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MR. HENRY BESSEMER.

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IN the great career of self-elevation, which is the destiny of man, the exercise of his inventive faculties occupies a conspicuous position. By their activity he learns to control the forces surrounding him, and to apply new forces when those fail; he learns to handle the crude material of the universe, and mould it to his own purposes in enhancing his dominion over nature and augmenting his own convenience and happiness; and while so employed he finds his own individuality in a perpetual state of development that apparently is illimitable. The orator warms as he beholds the prodigies of human skill and power, and the statesman finds political administration greatly facilitated by the ever-increasing productiveness of a community which contains among its members many of those gifted specimens of the race whose labour and patience perpetually augment the wealth and engage in contented industry so vast a section of the mass over whom he has to rule.

Distinguished in our time must be the name of Mr. Henry Bessemer, whose numerous discoveries, embodied in no less than 114 patents, occupy so interesting a space in our English chronicle of inventions. Of these, the drawings alone fill seven large volumes, every one of which has been his personal handiwork. Honoured he must be—although no royal recognition has fallen to his lot in his own land—honoured immeasurably above the crowd of nobodies upon whom such distinctions are showered in ridiculous profusion because they happen to have been the accidental holders of some civic office of the most fleeting character at periods of pomp and ceremony; honoured when men reckon up from among their numbers those whose services have caused a diffusion of knowledge, power, and wealth through the community.

The youngest son of a country gentleman, Henry Bessemer was born in Hertfordshire in the year 1813, at the hamlet of Charlton, in the parish of Hitchin, and the retirement of that secluded village afforded him a suitable opportunity for cultivating his inherent love of form, and his faculty for resource under disadvantageous circumstances. His early intelligence applied itself to the creation of designs and to modelling in the clay—two employments very familiar to the last generation of youth for the wealth of leisure rural life afforded; and at the early age of nineteen we find him exhibiting one of his beautiful models at the Royal Academy, then held at Somerset House. As his mind acquired power he turned to the study of the laws of structure and motion, cause and effect, and that enabled him to realize in more permanent forms the forces he observed to exist in mind and in matter,—in idea and in nature. In these processes he soon began to gather knowledge in the departments of mechanics and engineering. These tendencies had his father's approval, and the inclinations of the son were not interfered with in the disposal of his time, while every opportunity of ministering to their growth, by rendering such aids as could be collected to stimulate his powers, and give him delight in their exercise, was supplied. After a few years the family removed from the country, and took up their residence in London for, as it would seem, the purpose of facilitating the studies and promoting the interests of those who had their way to make in the world. But Henry, who had now reached eighteen, he did not think proper to place in any profession, but left him to go on in the good way his nature and powers seemed to indicate as his vocation.

It is stated of him that, when engaged in ornamenting a vignette in his sister's album for which he required some gold bronze, he was struck with the absurd contrast in the price of the raw material and the manufactured product, the one being a shilling and the other ninety shillings per pound. On examination he learned that the cause of this difference lay in the prolonged and laborious process employed in its manufacture, and he set about constructing some mechanical apparatus that would diminish the toil and the cost. He soon found that his idea had engaged the brains of other men unsuccessfully, but he persevered, and in about two years of labour and great efforts of skill, in which disappointment had a great share, he contrived, by constructing a series of five distinctly different self-acting machines, to supersede hand-labour altogether in this manufacture. These machines, which required only two attendants, produced as much bronze powder daily as could be made by sixty skilled operatives working on the old hand system; thus, while the article was of the most uniform and excellent quality, its cost of production was under six shillings per pound. It is a singular fact that this process still remains a profound secret, and is to this day carried on by the same persons to whose honour and discretion it was confided nearly forty years ago.

The large profits resulting from this, his first essay in mechanical improvement, enabled Mr. Bessemer to devote himself exclusively to experiments and researches in other branches of the mechanical arts, and to give the fullest scope to his inventive faculties.

It is impossible in the limits of this article to give even a mere catalogue of such of his inventions as he patented. They refer to the casting of printing types and improvements in the moulds, and the application of a counting machine, so necessary in a type foundry; to the checking of speed or stopping of railway carriages; to the manufacture of glass by a new construction of furnaces, and the annealing table; to new pigments and their preparation, and the treatment of varnishes, oils, and gold size to improve the fixity of metallic powders; to improve the coating and silvering of glass; to improve the construction of railway wheels, tires, axles, and carriages, and the combination of iron and steel in such work; to improve the machinery of the sugar refiner; to increase the facilities for producing ornamental surfaces on woven fabrics and leather; to new methods of throwing and making new projectiles, ordnance; and, finally, to the manufacture of iron and steel, and the methods and uses to which they could be applied as to railway bars, anchors, cylinders, crushing machines, &c., &c.

This list covers a very extensive range of subjects which cannot be referred to at greater length. The result of his experiments on the nature and manufacture of iron and steel is seen in what is familiarly known as the Bessemer process, the announcement of which in 1856, at the Cheltenham meeting of the British Association, startled the scientific world, and well-nigh created a panic in Birmingham. As the conclusions then reached have been verified by experience, and no essential alteration has been made in the system it prescribes, we will recapitulate the chief points in that new system of operations for the manufacture of malleable iron and steel, by which the crude metal is converted by one simple and direct process. Mr. Bessemer's attention had been engaged for two years almost exclusively on this subject, and the toil had almost exhausted his patience, when an entirely new view forced itself on his mind, viz., that he could produce a much more intense heat without the employment of fuel than any furnace had ever produced, and, if so, he would not only avoid the injurious action of mineral fuel upon the iron, but effect a great saving therein. After a laboratory experiment he put up an apparatus capable of converting 7 cwt. of crude pig iron into malleable iron in 30 minutes.

He had set out with this reasoning: crude iron contains about 4 per cent. of carbon; and carbon cannot exist at a white heat in the presence of oxygen without union and combustion, the rapidity of which combustion would depend on the carbon surface exposed; and the temperature of the metal would depend on the rapidity of the combination of carbon and oxygen; consequently it was only necessary to bring the oxygen and carbon together in such a manner that a vast surface should be exposed to their mutual action, to produce a temperature hitherto unattainable.

He constructed a cylindrical vessel 3 ft. in diameter and 5 ft. in height, somewhat like a cupola furnace, and lined it with fire brick; two inches from the bottom he inserted five tuyere pipes, the nozzles being of well burnt fire clay, and the orifice $\frac{1}{4}$ in. diameter. At one side of this vessel, half way up, was a hole to run in the crude iron at, and opposite it a taphole stopped with loam to run the metal out at when ready. This vessel held about 5 tons of fluid iron at a charge, and should be near enough to the blast or cupola furnace to allow the iron to flow along a gutter into it. A blast-engine capable of compressing air to about 15 to 20 pounds per square inch is connected by suitable pipes with the tuyeres of the converting vessel. These tuyeres being at the bottom of the vessel, the fluid metal rises some 20 inches above them, and to prevent the metal entering these holes the blast must be turned on before the crude iron arrives. This done, the fluid runs in, and a rapid boiling within the vessel occurs, tossing the iron violently about, dashing it from side to side, and shaking all the apparatus. Flame and a few bright sparks rise from the throat of the vessel; this goes on for 15 minutes, during which time the oxygen of the atmosphere is combined with the carbon of the iron, producing carbonic acid gas and evolving a powerful heat.

The heat thus generated is diffused in innumerable fiery bubbles throughout the whole mass of the fluid, the metal absorbs the greater part and immensely gains in temperature, and at the end of the 20 minutes that part of the carbon which is mechanically mixed and diffused through the crude iron, is consumed. The high temperature liberates the chemically combined carbon from the metal, and a huge flame issues from the throat of the vessel; the metal rises several inches, and a frothy

slag appears, and is thrown out in large foam-like masses. This eruption continues 5 or 6 minutes, the shower of cinders ceases, and a powerful and steady flame appears. The rapid union of carbon and oxygen which thus takes place adds to the heat of the vessel, the diminished carbon allows part of the oxygen to combine with the iron, which undergoes a combustion, and is converted into oxide. This oxide fuses as it forms, and is a powerful solvent of the earthy bases of the iron. The violent boiling now going on thoroughly mixes the scoria and metal, and every part is in contact with the fluid oxide which cleanses the metal from silica and the other earthy bases in crude iron, while the sulphur and other volatile matters are driven off, the sulphur combining with the oxygen and forming sulphuric acid gas. This conversion entails a loss of 12½ per cent. of the crude metal, which is increased to 18 by the further loss entailed in the finishing operations; but the old system of manufacture causes a loss of 28 per cent., besides which the refuse herein obtained is a valuable product.

When the conversion of crude iron into pure malleable iron is effected, the vessel is turned on its axis and the metal flows into the casting ladle, from which it is conveyed into the iron ingot moulds. Thus, with a few attendant workmen, five tons of crude pig-iron pass in 20 to 25 minutes into ingots of malleable iron at an expenditure of no fuel beyond what the crude iron itself contains.

Some technical details follow, which are not necessary for our purpose. "In conclusion," says Mr. Bessemer, "the facts I have discovered have not been elicited by mere laboratory experiments, but have been the result of operations on a scale nearly twice as great as is pursued in the puddling operations of the largest iron works, the experimental apparatus converting 7 cwt. in 30 minutes, while the ordinary puddling furnace makes

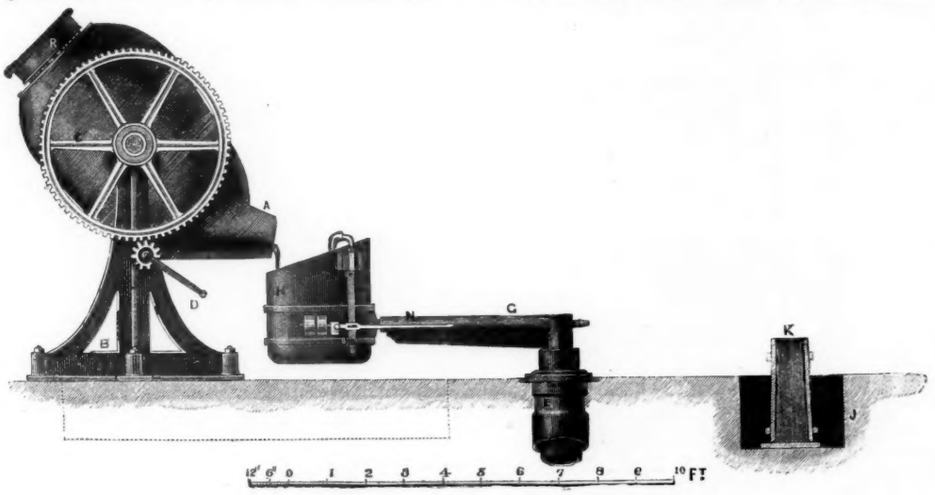

Fig. 1.

only 4¼ in two hours, which is turned out in balls, while in this, my invention, the ingots are smooth, regular prisms, 10 in. square by 30 in. in length, and weighing as much as 10 of the balls, therefore, more available for rolling, &c."

The last two items in the above list of patents refer to improvements which he made in the three years following his Cheltenham address, and in 1859 he appeared before the Institution of Civil Engineers with his system as perfect as it is at this day. There he met some of the ablest practical gentlemen connected with the production and use of iron and steel. After he had read his paper, discussion followed, in which Messrs. Locke, Bramwell, T. Brown, Gladstone from Thornycrofts, Colonel E. Wilmot, E. A. Cowper, and Riley took part, and Mr. Bessemer replied. His child had something besides blessings on entering existence. The Birmingham Press wrote some ridiculous articles, and many wise men said many foolish things, but they all tried hard to ignore the project, or at least to treat it as visionary and impossible. There were certainly some grounds to doubt the practicability of Mr. Bessemer's invention, especially as regards the production of cast steel thereby. Here was a material, the market value of which, at that time, ranged in Sheffield at from £45 to £60 per ton: a material which required finished bars of the best iron for the crude material of its manufacture: these bars had to be kept continually at a white heat, in large stone boxes of charcoal powder for a space of no less than three weeks, and when cooled down after that long converting process (by which they became crude steel) were broken into short pieces by the hammer, and put into clay crucibles in quantities of not more than 40 pounds in each, and for their fusion the most powerful furnaces employed in the arts were required; and besides that, the melting process consumed about 4 tons of the best hard oven-made coke for each ton of crude steel so melted, and occupied a period of about a month in the transition from bar iron to the ingot of cast steel.

No wonder then that practical men could not at once realize the fact, that, by the Bessemer process, pig iron (and not finished iron bars) was the crude and cheap material to be dealt with, and that from this first low material of the blast furnace a cast-steel ingot could be produced in a space of twenty to twenty-five minutes, without any of the coals employed in the first three weeks of the old process or one pound of the four tons of coke required for melting the bar steel in crucibles; and further, that by the Bessemer process, quantities of five tons, and not forty pounds, could be treated at one time. Cast steel was at that time too costly to be employed for anything but best work of the highest class; a bar, of the weight of an ordinary railway bar, about 500 pounds, had never been sold in Sheffield at so low a price as £40 per ton, and the entire make of cast steel in Great Britain was, according to the Jurors' Report of the Exhibition of 1851, only 51,000 tons annually. At the present time there are made in England alone, over 500,000 tons of Bessemer steel, the greater part of which is sold as rails at from £9 to £10 per ton, which quantity of steel could not have been made by the old crucible process without a consumption of at least six millions of tons of coals more than is now employed in its production.

It is worthy of remark that one of the most important applications of cast steel to modern engineering operations is the manufacture of steel tyres for locomotive-engine wheels; these were originally imported into England at a cost of £120 per ton, and after some years of competition the price of steel tyres sank to from £60 to £70, at which they stood firmly at the date of the Bessemer invention. Soon after that the price receded rapidly, and steel tyres are now quoted at £13 to £15 per ton.

The extreme tenacity and toughness of Bessemer steel render it particularly suitable for shipbuilding, and for the manufacture of steam boilers. At this moment the London and North Western Railway Company have over three hundred locomotives in use, the boilers, axles, cranks, tyres, and other important parts of which are made entirely of Bessemer steel.

As an example of the difficulty in producing large masses of cast steel by the old process in those days, it is worth while to mention that, at the International Exhibition of 1851, an ingot was exhibited by one of the largest steel makers in England, weighing 240 pounds, with a label stating that "this monster ingot was cast on such a day, at the works of Messrs. ——— of Sheffield." Since that time there has been cast by the Bessemer process at the works of John Brown and Co. of Sheffield an ingot weighing twenty tons.

Here it may be interesting to show in what manner the process is carried into practical operation.

The vessel found most convenient is mounted on axes at or near its centre of gravity, and is constructed of boiler-plates lined with fire-brick, or "gannister"—a kind of powdered stone that resists heat better than any other material, and is cheaper. When heated it is put into position to receive the charge of molten metal, without either of the tuyeres being below the surface, and of course no action occurs until placed in a slanting position, when the process is in an instant in full activity, and small powerful jets of air spring forward through the fluid mass. This air, expanding, divides itself into globules, or bursts violently upwards, carrying a hundredweight or more of fluid metal, which returns to the mass below. Every part of the apparatus trembles, a roaring flame issues from the vessel's mouth, and presently its violet hue is changed to orange, and finally to pure white. The large sparks change to small hissing points, and these disappear to soft specks of bluish white as the state of malleable iron is approached. The eruption of cinder in the first experiments does not now occur; the improved shape causes its retention, and it acts beneficially on the metal, helps to confine the heat as it grows into a temperature vastly greater than any known welding heat, and thus the iron becomes soft enough for the hammer. Here it is perfectly fluid. The heat is evolved at thousands of points, and is distributed through the fluid, which, when it boils, the mass rises far above its level, and forms a spongy froth, with an intensely vivid combustion going on in all its innumerable and changeful cavities. Thus a temperature is obtained in ten or twelve minutes that whole days of exposure in the most powerful furnaces would fail to produce.

In the early stages of invention the converting vessel was

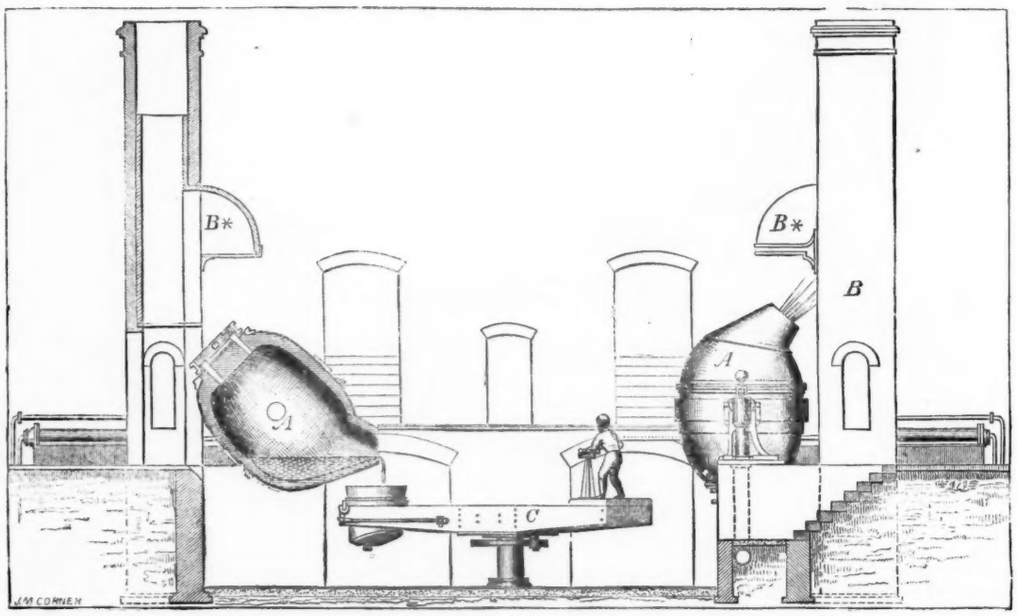

Fig. 2.

fixed as in an ordinary furnace; but the difficulty of tapping the metal from it, together with the impossibility of stopping the blowing while any remained in the vessel without filling the tuyers with the fluid, induced Mr. Bessemer to construct a converting vessel mounted on axes, so that the vessel might be inclined in such a position that the tuyeres would be above the level of the metal when it was poured in. A rapid movement of the vessel on its axis brought the tuyeres down below the fluid level, and at once set the process in operation. This axial movement of the vessel allowed the tuyeres to be again moved above the level of the fluid, thus stopping the operation, and allowing the metal to flow into the casting ladle, as shown in fig. 1. These movements were effected through the agency of a spur-wheel and pinion, the lever D in the axis of the latter being worked by hand.

It is essential in the casting of steel ingots that none of the scoria flowing on the surface of the metal should be allowed to enter the mould; consequently, pouring from the surface of the vessel becomes almost impossible without such a result. Again, the curve stream produced by pouring is liable to come in contact with the sides of the mould, the result of which would be a fusion of that part of the mould touched, and a soldering of the ingot to the mould. It therefore occurred to Mr. Bessemer that the metal should, if possible, be allowed to flow from an opening in the bottom of the ladle, vertically, as shown in fig. 3, into the mould K. For this purpose a cone-valve is formed on the end of the rod and attached to a rod on the exterior side of the ladle, and worked with a hand lever as shown in fig. 1. By this means the rapidity of the flow is regulated; and as soon as the mould is full the valve is closed, and the crane-arm G is moved round so as to bring the ladle vertically over the other moulds in succession. By this simple device the moulds are filled without sustaining any injury, and the slag is retained on the surface of the metal. The valve is formed simply of a plug or piece of

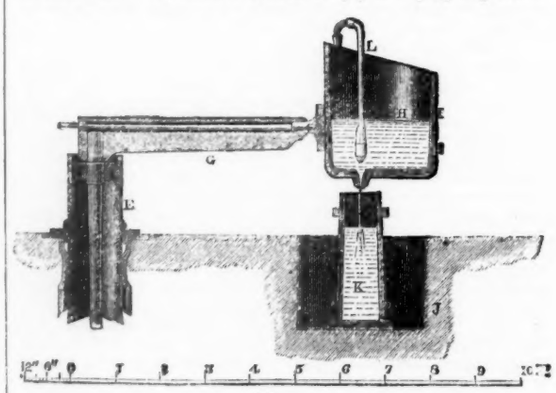

Fig. 3.

fire-clay, which is destroyed at each operation, but readily renewed at a cost of twopence.

When carrying out the process on the present gigantic scale

it was found that the wheel-and-pinion was inadequate to control the movements of a vessel weighing 10 or 11 tons, and containing 5 tons of fluid, because the balance of the moving vessel was altered. The force therefore required was extremely irregular. To meet this difficulty hydraulic apparatus is employed, by which the vessel is under the perfect control of the operator, who occupies an elevated position some fifty feet distant from the vessel, but is nevertheless able to manipulate by the simple movement of a handle. The crane on which the casting ladle is fixed is moved in the same manner.

The general arrangement is better understood by referring to figs. 2 and 4. The latter is a plan of the converting-house, and the other the view. Two vessels A A are employed, and are placed so as to throw the sparks and slag away from each other into the chimneys B B, which have hoods, B, to conduct the flame into them. The casting-pit is semi-circular in form with the casting-crane C central, supporting the ladle as it receives the fluid steel and delivers it into the moulds D D. Both can be used if necessary at one time, so that an ingot of 10 tons can be made by a 5-ton apparatus. The casting-crane C is brought forward so as to allow one vessel to be moved while the ladle is in front of the other, thus giving more space for the moulds. In pouring, the crane is lowered steadily by the boy on the valve-stand, and its head moved round according to the path, passing under the spout. On this stand the cocks are placed for moving the vessels, and there are the handles of the air blasts that regulate the blast. The old crane was most inconvenient and wasted much time, and Mr. Bessemer invented a new one that can be worked by one man and a boy with ease and surprising rapidity, which crane is so adapted as to be employed for moving forgings under the largest steam hammer at the Sheffield works.

The changes in colour, and volume, and sparks, enable one

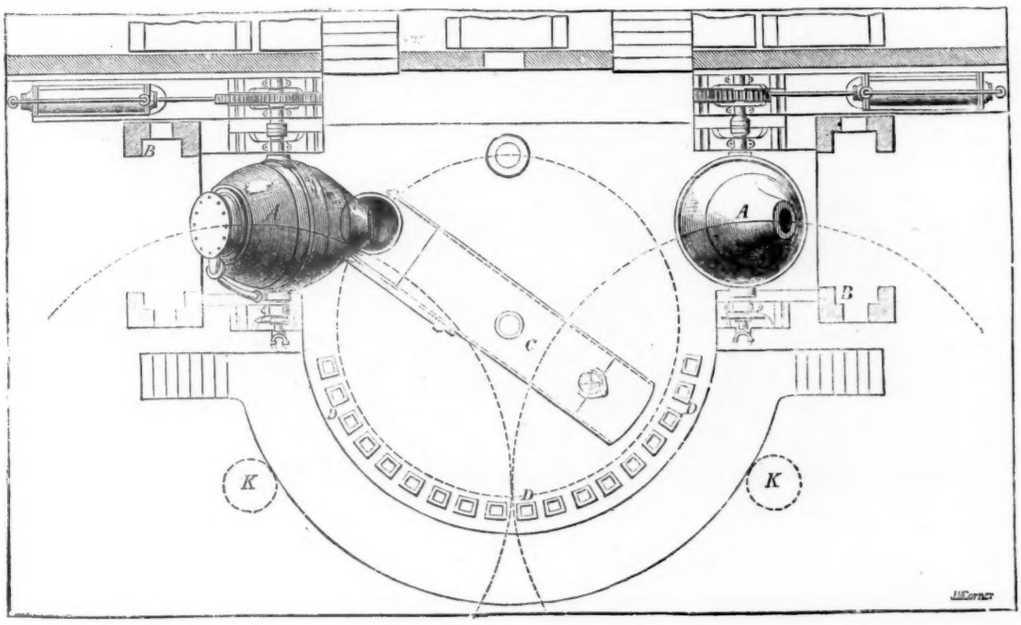

Fig. 4.

easily to judge of the state of the metal, and the sound emitted is a good indication to the workman: the required hardness can be regulated at pleasure. When sufficient air has passed, the vessel is turned on its axis, and the fluid steel is poured out, as in fig. 2, into the casting ladle attached to a hydraulic crane, and brought over the moulds; a plug in the casting-ladle is raised by a lever, and the fluid steel descends in a clear, vertical stream into the moulds. These operations are repeated until the vessel is emptied.

The importance of these discoveries is evident, because iron will be superseded by steel, as the process which yields malleable iron can as readily supply malleable steel, and at no greater cost. Until recently cast steel has been considered to be a hard and brittle material, which could only serve to make cutting tools, because, being so hard and difficult to work, it was unfit for general purposes; but Bessemer steel will bear a strain of 60 to 80,000 lbs. per square inch, which is 50 per cent. more than the best iron. To show that, with this amazing tenacity, toughness is secured, fig. 5 contains a photograph of Bessemer steel bent or twisted cold. Among them are two pieces of a cast-steel rail, one formed into a spiral that partly untwisted itself when released from the machine, and the other was doubled by a 2½-ton steam-hammer. There is also a 3-inch square bar, so twisted that its angles present the appearance of a screw. Also a representation of what may be called a steel cable twisted from three rods of steel each of 1½ in. diameter. Cast steel, therefore, does not snap like glass when made by this process, and it can be safely employed as a substitute for wrought iron. Ordnance of great strength has been made of Bessemer steel, and we know how successfully those stupendous instruments have been made and manipulated after casting. Krupp in Prussia, Elfstrand in Sweden, Jackson at Bordeaux, the empires and kingdoms of Sardinia, Russia, Belgium, and France have all adopted the Bessemer process, which has become the established mode.

The Institution of Civil Engineers recognized the services of Mr. Bessemer by conferring upon him the highest honour at their disposal, the Gold Telford Medal, in the following Session: and on the knowledge of his discoveries reaching Europe, honours were thrust upon him. The Crown Prince of Sweden personally inspected the first operations in making steel from the iron of that kingdom, and he was made honorary member of the Iron Board of Sweden, of which the Prince was President. Similar tests having been employed at Hamburg, that ancient and free city conferred upon him the freedom of the corporation. The experiments were repeated in Wurtemburg, and the king presented him with a gold medal, accompanied by an autograph letter of thanks. Then followed the adoption of the process at Demedorf and the Northern Railway Works at Vienna, and the Emperor of Austria conferred on Mr. Bessemer the cross of Knight Commander of the order of his Imperial Majesty Francis Joseph, accompanying it with a complimentary autograph letter. Nor were the Americans, who possess unknown regions of coal and iron in their territories, forgetful of the obligations under which this inventor laid them. A town sprang up upon a district of coal and iron ore in the state of Cincinnati, and while our transatlantic cousins have abundance of inventive genius and do not forget to bestow upon their sons the deserved honours, they had the grace to award this distinction to the Englishman—they named the new town Bessemer; and a prosperous place it is, and in it is a Bessemer factory for the production of iron and steel. But in his own country, where his inventions have added an entirely new manufacture and become a source of wealth in effecting a saving of

several millions of tons of coal annually, and of giving employment to many thousands of persons, adding, moreover, immensely to the comfort and safety of the travelling public on every railway in the kingdom, besides effecting a saving of enormous sums in the wear and tear that diminish the shareholders' dividend—for the consumption of Bessemer steel for railway purposes alone amounts to over five millions sterling per annum—yet notwithstanding all these benefits conferred, we not only find Mr. Bessemer wholly unrecognized by our own government, but our ministers absurdly refused to permit him to receive the well-merited honour which His Majesty the Emperor of the French desired to award him when the arsenal authorities of that country reported the success of the tests they had applied, and suggested the propriety of awarding the inventor the Grand Cross of the Legion of Honour. The Emperor was displeased with the English ministry, and although the Grand Cross could not be conferred, he took the opportunity of presenting, in person, a magnificent gold medal, and expressing at the same time his high sense of the benefits derived from the invention.

In 1872, the Council of the Society of Arts, &c., in England conferred on Mr. Bessemer the Albert Gold Medal, "for the eminent services rendered by him to Arts, Manufactures, and Commerce in developing the manufacture of Steel." This medal is a most distinguished honour, for it is not a competitive one. The Prince Consort bequeathed it to be granted to those of any nation whose service conduced to the elevation of art, and the advancement of manufacturing and mechanical power. The Prince of Wales in person handed it to Mr. Bessemer on behalf of the Council.

Mr. Ramsbottom, the chief engineer of the London and North Western Railway Company at Crewe, was the first to fully realize the immense advantage of the steel rail, and the further

Fig. 5.

applicability of the material in the construction of engines, carriage-wheels, and axles. It was after a most searching examination and the employment of the most severe tests that he resolved, with the entire consent of the directors of his company, to introduce it on that line, and from that time to this, Bessemer rails have been accepted, the cheapest and most durable material for permanent way. It happened in 1866 that Mr. Williams read an elaborate paper before the Institute of Civil Engineers on the maintenance and renewal of permanent way, and said,—The introduction of steel rails within the last few years, manufactured by what is known as the Bessemer process, and the highly encouraging results obtained, encourage the belief that a material has at last been secured which will give permanency to what has hitherto little deserved that title. In 1862 some steel rails were laid at Camden Town and Crewe, where from the heavy traffic iron ones lasted but a few months. Two 21 feet rails laid on May 2nd, 1862, at Chalk Farm Bridge were, after outlasting sixteen faces of iron rails, taken out in August 1865, and the one face only which had been exposed during the three years to an enormous traffic amounting to 9,550,000 engines, trucks, &c., and 95,577,240 tons, although evenly worn to the extent of little more than a quarter of an inch, appeared capable of doing a good deal more work. A long discussion followed between the most eminent civil engineers in the kingdom, turning practically upon the question of cost, to which Mr. Bessemer replied in a lengthened and conclusive statement, proving the saving of money, labour, time, property, and life which would be obtained by the adoption of what all the tests had proved to be the only permanent way. So the matter ended, and the verdict of all subsequent experience confirms the absolute truth of the inventor's calculations and inferences.

These successes among scientific and engineering bodies induced the Iron and Steel Institute to elect Mr. Bessemer their president in 1871, as the successor of the Duke of Devonshire, and his address on taking the chair was delivered at Willis's Rooms on March 28th. After referring to the inaugural address of his noble predecessor, who recited the history of the iron manufacture from early times to the present, he discussed the processes of mechanical puddling, which presents so many practical difficulties as to have heavily taxed the inventive talent and perseverance of many able and energetic men, notably Mr. Menelaus, of Dowlais, in Wales, and M. de Wendell and others in France, and expressed his conviction that while these laudable efforts in the mechanical department were progressing, the chemical side of the question had not been lost sight of. He reminded the members that in the early part of this century the various qualities of iron made in different districts were supposed to be the result of an inherent difference, such as occurs in various kinds of wood; a theory which chemistry has destroyed by showing that it depended on the combination of other elements, and hence that it might be possible to produce from every kind of iron ore a pure and perfect metal. The manufacturer now knows that by his laboratory he must learn the quantity and quality of sulphur, phosphorus, and other deleterious substances, and find the means for their elimination; in that field Mr. Henderson, of the United States, and subsequently Mr. Sherman, also an American, had been eminent. The latter gentleman employed iodine in various forms, which he brought into contact with the metal in the puddling furnace or in the Bessemer converter. The question to be solved commercially turns simply upon how far the low-priced pig iron could be made to equal the quality of the purer brands, and at what cost.

Passing from that, he noticed the improvements effected by Sir Joseph Whitworth in casting under hydraulic pressure, and referred, in passing, to his own labours in that direction in 1856, with the view of extolling the success of that eminent engineer in producing the material known as the "Whitworth metal;" and then noticed the beautiful castings in steel produced in Germany by the Bochum Steel Company, and those of equal merit by Messrs. Vicars and Co., of Sheffield; and then adverted to the im-

provements in the production of armour-plates called for by the advances in modern artillery and men-of-war.

He then referred to the important position held by the Iron and Steel Institute in defining the difference between iron and steel substances, which graduated into each other like rainbow hues, but which must be classed into three, viz., cast iron, wrought iron, and steel; the two former the world had for ages known much of, but of the latter little as yet had been reduced to certainty. He recognised very warmly the labours of Huntsman the ingenious clock-maker in the early part of the 18th century, who produced cast-steel—a material until then unknown; and traced from him the growth of the manufacture, especially in producing mild cast-steel, so necessary for modern engineering structures, and of which so little as yet has been positively ascertained. He commended to the notice of the Institute a series of preliminary experiments, showing the difference of resistance in the several materials as to their tensile and compressive force, through the testing apparatus of Mr. Kirkaldy, of Southwark. Further, they would find it no less interesting to ascertain how far the combination of wrought iron and steel in one structure could give the greatest amount of stability and at what cost; and finally, for rails, he contended, *the price per mile, and not the price per ton, was the real test of cost:* to this end he would have a standard, or standards, recognized in some such form as *a b c* rails, which, by conference with leading engineers, might be adopted to the advantage of all concerned, leaving for exceptional estimates the outside sizes. These suggestions he offered with diffidence; but, assured that the gentlemen he addressed were more able than himself to form correct opinions, he would obey his impulse by tendering these observations about steel, because on that subject he had had considerable experience.

We cannot close this notice better than by a reference to an invention of still greater importance connected with the manufacture of Iron and Steel, which Mr. Bessemer patented in 1868, and which, previous to doing so, he had tried on a scale amply sufficient to demonstrate the soundness of the principle on which it is based. So important did he consider the subject, that he pursued his experiments so energetically as to injure his health and bring upon him the order of his physicians to stay or take the consequences. He broke down under the mental strain, and was laid aside to be despatched into the country in the hope of recruiting his lost powers.

The importance of this invention acquires interest, in that it opens to view a novel principle which seems to be applicable to all purposes in the arts where extremely high temperatures are essential.

We have in our laboratories a source of extreme heat in the electric light, and in the oxy-hydrogen blowpipe; but these are not applicable to the great manufactures of the kingdom: for these we must rely upon the combustion of coal supplied by atmospheric air. Assuming these elements to be brought together in the best manner for any special purpose, we arrive at a maximum temperature beyond which we cannot go; and this maximum heat is wholly insufficient to fuse or evaporate a vast number of substances, all of which have their fixed fusing temperature, nor can time aid us in their reduction; thus, the common domestic fire-grate will fuse a piece of lead in a few minutes, but it will not fuse the end of a poker if kept there for months together. Therefore, temperature, and not time, must be increased.

The temperature of all gaseous bodies increases their volume at the same time; an addition of 480° Fahrenheit expanding one cubic foot so that it occupies two cubic feet, and so on for all additional heat. Now, the same amount of heat which existed in the larger space is condensed into the smaller one, which is consequently doubled in the temperature it would have been if that expansion had not taken place; as an example, it is well known that in compressing common air great heat is developed. If two cubic feet of air, at 60° of temperature, be suddenly compressed into one, the temperature will rise to 120°.

With a knowledge of these facts, Mr. Bessemer designed a furnace enclosed in a strong iron case, like a steam boiler, and into which air was forced to a pressure of 20 pounds on the square inch; the orifice of escape was a small round hole of 1¼ in. diameter, and with this small aperture the internal pressure was kept at 15 to 16 pounds above the external air, or at two atmospheric pressures. Hence, all the heated gaseous products of combustion were compressed into one half the space they would have occupied in an ordinary furnace with a corresponding increase in temperature. To test this temperature, a piece of bar iron, 2 in. square by 1 ft. long, weighing 13¼ pounds, was put, while quite cold, into the model furnace, and in 5½ minutes it was melted to the fluidity of water. Our best furnaces would have required two or three hours to effect such a change. As much as 3 hundredweights of malleable iron, put in cold, was fused (without any addition of pig iron), in fifteen minutes, proving, beyond all doubt, the important fact, that with ordinary fuel *there is practically no limit* to the temperature that may be attained, provided there is additional pressure. Mr. Bessemer has stated his conviction, that nearly every substance known to man may be fused, and probably nearly all be volatilized on this system, and that, at some future time, it is not too much to expect that the distillation of metals may be found the most ready and perfect mode of purification.

It will at once strike the reader that this invention opens a prolific field of inquiry, but he will probably see an apparently impassable barrier raised up by nature and which must check all advance in the new direction: for the excessive temperature capable of being produced under a high state of condensation of the products of combustion naturally threatens to destroy the internal lining of the furnace, of whatever it may be composed.

Here again Mr. Bessemer's fertility of resource avails. He successfully grappled with that apparently insurmountable difficulty, and, strange to say, the destruction of the furnace lining is actually very much less rapid than in an ordinary furnace. It is purely a question of the conducting power of the material employed. Thus, in an ordinary furnace, a wall of fire-brick, 9 in. thick, conducts heat so slowly that the interior is soon burned away, because very little of the heat it acquires can pass off externally. But the high-pressure furnace is built in a double case, in the intermediate space of which cold water circulates freely. The interior lining of gannister (a powdered stone, 93 per cent. silica), is rammed in close contact with the inner surface, and which contact the internal pressure of gases always keeps up. This lining is only about 3 in. in thickness. The part of it which is in actual contact with the cold iron shell is black-cold, a little further on it is blood-red, on the face it is white and brilliant as the sun. According as the heat of the furnace is increased, so some of this face will melt off, but it will always come to a point where the cooling influence of the external wall of water will prevent further melting away, and here the lining becomes permanent.

The great economy of such a system of fusion, and the vast number of purposes to which it might be applied, seems to open up a future which is absolutely illimitable, and yet this new power lies dormant. After a very active and prolonged career, Mr. Bessemer evidently fears to incur another warning from his physician by plunging anew into the vortex of mechanical inquiry, into which this grand idea would lead him. Perhaps there could be no better illustration of his known views of the patent question than the position of this discovery. He is known to hold strongly to the conviction that an invention freely given to the public is an invention wasted and thrown away. No one will nurse the foundling, and expend upon it time, talent, and money required for its rearing, and it perishes. Thus is it with the invention of his high-pressure furnaces. For seven years has it been recorded in the Patent Office, but no one applies it to his own special purposes; no one asks permission to work it; and as it is manifestly absurd to suppose that the health of the discoverer would bear the strain of future toil, by a repetition of his old energy in the combating of prejudice and the stolid opposition of vested interests, his greatest work remains on the annals of the mechanical arts, a dead letter, and for present usefulness might as well never have been done.

That this will continue we do not believe. Public spirit is very susceptible to the influence of example, and the energetic career we have so feebly described must have its effects upon the rising generations of men, some of whom will raise again the standard of one who has proved himself to have been, not only a pioneer, but a captain in the great work of mechanical advancement for public usefulness.

W. S. C.

INDUSTRIAL ART.

THE universal enjoyment of beauty, in form and in colour, whether exhibited in natural or artificial objects, and the changes of appreciation and increase of gratification, which proceed from custom, fashion, and habit, is a fact in human, if not also in animal nature, whose existence and influence must be admitted. Cleanliness, neatness, and order, either in person, clothing, or the commoner accessories of civilized life, form one standard of beauty, for the attainment of which half the lives of woman, if not of mankind, is devoted; and passing this lowest standard of luxury, every rank, station, or condition

of life establishes and values some relative tastefulness in its belongings. The writer well remembers how the monotony of a long railroad journey was relieved from the continued perspective of frozen level fields, by the back view of two bonnets, made from dove-coloured silk, of artistic perfection and spotless beauty, with plaits in the most regular folds, enveloping the shape of the lovely coal scuttle, and with the radiant point of plaiting hidden by the neatest of minute bows. The geometrical considerations upon the lines of intersection indicated by the folds, were scarcely more abstruse and insoluble than the theological reflection suggested by the show of taste; and it is yet an undetermined question whether those particular bows were pomps or vanities, or a special dispensation. Even professed abnegation will not annihilate the fashion. When reduced to the elements of bare requirement, the Friends' male attire becomes something surprising. Given any article of necessity, comfort, or luxury, no asceticism has ever overcome the love and desire for the beautiful; predominant always when necessity or comfort are equal, and frequently asserting themselves over either needs or desires.

With this existing and universal fact of demand, neither excellence nor cheapness of production warrants those who are engaged in industrial pursuits in neglecting the knowledge, or more properly the educated ability, of the artist. Whatever is made to be sold, especially must—regardless of the homeliness of purpose—have beauty of design or of colour, together with good workmanship. All these qualities go to make up a value or price to the purchaser.

But it must not be assumed that because the desire for prettiness is pervading, and because there is an individuality in estimation or choice of handsome things, therefore taste is a matter of fashion, style, or caprice; that either general demand by the most votes, or the personal opinion of one individual will suffice to make handsome things. Capability to design, either in line or colour, comes to no one as Dogberry has it "by nature;" nor does individual or national appreciation of beauty become elevated, much less perfect, except after study, or at least familiarity with good examples. Owen Jones calls his book the "Grammar of Ornament" and there is a great propriety in the name. The laws of design are as definite as those of language, with much the same questions as to order, relationship, construction, or elegance; differing for dissimilar styles as for divers tongues. The pupil in design has similar obstacles to encounter with those of the schoolboy in his alphabet and grammar; the ability to use the pencil or the brush will no more produce an artist, than the acquirement of the writing master's art, combined with all of Murray's rules, will make a poet; and a parallel kind of education to that which supplies admirers for the picture, gives readers for the poem.

A style of architecture or of line or colour decoration may be appropriated and accompanied with incongruous details or effects, and the result may be striking, admired, or fashionable, but with examination or time will depart the gratification of first view and a simple feeling of ugliness will follow.

Except that the principles of ornament have been read about and investigated far enough to discern, few people, only those with artist eyes—eyes which but rarely are found in northern European nations or their descendants—can recognize the fitting nature of each ornament to its style, and how painful to the unlearned, as well as to the learned, are departures from rules. This condition of taste can be well exemplified in any dry goods shop, by looking over a collection of old prints and seeing how some of them seem uncouth in line, irregular and unsatisfactory in colour, while others of the same type and fashion produce at once an impression of suitability, elegance, and beauty. One remarks that nobody would wear such a pattern to-day, but it is very pretty, or showy, or effective! Why these characteristics attach to some of the patterns and not to others, the educated artist can at once detect. Not that everything which is handsome is in style to sell, but that that which is in style and is handsome will sell best. Every maker or seller of jewellery or ornaments, carpet, or hangings, of prints or laces, finds some patterns which sell with great regularity, while others which may sell rapidly at first, quickly lose all demand; and most accomplished salesmen can select with certainty what will probably sell, after novelty has passed away.

The writer has a considerable collection of fashion plates for the present century, and interspersed with them are "fancy dresses" of corresponding dates. Remarkably, not singularly, the fancy dresses of 1800-10, 1810-20, 1820-30, 1830-40, 1840-50, and so on, *are all alike*, however dissimilar the style of dresses which varied from skirts three-quarters of a yard to those of six yards in circumference, within those dates. The *elegance* of all these costumes was found in their approximation towards the fancy styles at any time. This example is strictly not quite applicable to the question of educated taste now under consideration, but the analogy is a correct one.

The attempt to combine beauties by appropriation of an ornament here, a decorative line there, the copy of red roses from one pattern upon the beautiful pearl ground of another, is a feature of English and of American industrial art; very cheap, very unintelligent, very inartistic, and it is gratifying to add, very unprofitable. The purchaser says there is an "I don't know what" about it, but she buys a French print or a piece of French jewellery when the English, German, or American fabric is much more durable and intrinsically valuable, and is in so far better educated in art than the Germanic or native maker or seller.

The education of the buyer in art is one of comparison, not one of reasonable ground for estimation, but however attained, this education has now reached an eminence far above our native capability to supply. A person does not stop to estimate the strength of the bridge which carries him over the stream. No one who has a rational enjoyment in his dinner, desires to know much of the mysteries of the kitchen; outside of mechanics' lectures and useful-information periodicals (which are imagined to have listeners or readers), the knowledge of an art is as great a bore as the enjoyment of its results is a pleasure. As in letters and as in music, so in art; the public taste becomes elevated by examples rather than by reasoning. The competition of examples is raising the standard in all regards.

Take, for instance, the painter's art. The competition of the photograph has given us a standard of correct drawing, shadow, and perspective, previously unknown. Forty years ago it sufficed to sketch a background, and the eye was demanded to tolerate errors of fore-shortening by the best of painters. To-day, no leniency can be admitted in these regards. The competition of the chromograph has already softened incongruous tints, and compelled the use of permanent colours of high natural tones. It is not supposed that either the photograph or the chromograph will take the place of the painting, but it is certain hereafter, that the painting must be superior in finish, in excellence, and in effectiveness to them.

In industrial art there are no photographs possible. The only mechanical additions to the art of design have been the engine lathe and the kaleidoscope. The use of the former has been fully availed of in its limited direction, but the arabesques of the latter in line and in colour are yet to be made use of in many applications.

The field of industrial art is of great extent and comprehension; the line between it and architecture is very imperfectly marked; furniture, wall decoration, carpentering, carving, etc., are adjuncts to the architect's work in churches, halls, or houses. In such branches—for industrial art must divide into branches, both in study and in practice—a knowledge by no means incomplete, of the corresponding art must be attained by the artist. But by far the most difficult and important study of industrial art, after the acquisition of the laws and rules of decoration, is the capability of the material to be treated, and the utilizing of the methods of decoration at command.

Take the well-known examples of method. The sand-blast which promised such beautiful results five years since, yet lingers comparatively unproductive; and mechanical wood carving has so far failed in effective or really tasteful work, while all artists admit the difficulties in both cases to lie in the want of designs, not in the method.

Unquestionably, many persons who have noticed the proposal to establish a school of design in Philadelphia, have looked upon the plan as a kind of easy amateur procedure; that a few lessons in handicraft would allow the student to compete for a prize, and qualify him or her to decorate, or at least design a decoration, in some style, either florid or severe; but such persons or their friends will learn with dismay, that given the highest of talent, years of study and pursuit alone can attain eminence, and that few will ever reach mediocrity. All that education can do is to teach. Application, readiness, invention, DESIGN, can only come to the educated mind and skilful hand, and the natural gift of art ability.

If this city—if the nation—is to secure and maintain its eminence as a manufacturing one, it must do it through its ability, not through its machinery, handicraft, or its cheapness of production. In some branches of workmanship the mechanical excellence and inventive superiority will keep the business in the hands of our mechanics, but even here the coupling with taste, both in form and colour, will prove advantageous; but in the textile fabrics, the furniture and jewellery, only original designs, not borrowed, not misunderstood or misappropriated, will preserve the tradesman and the workman from the local competition of every country town. The competition of unskilled labour is always destructive.

The success of a School of Industrial Art rests upon the same

basis as the success of schools in other branches of learning. First of all, upon the value which the Community shall set upon knowledge acquired; what pre-eminence, distinction, or reward shall be attached to the acquisitions of the student. Secondly, the Students; under the stimulus of elevated aims and hopes, the standard of selection of students can be brought to a high point, in mental, educational, and natural artistic ability, and the efforts and labours of students will have corresponding energy. Lastly, the Tutor; although the before-named conditions are the more essential, and although with a mere schoolmaster, the school may thrive, yet eminence in all things is individual, and attainments of the highest order, with capacity to impart them, must be sought and secured to fill the place.

It would almost seem proper that the school be made one of the branches of technical education, which are now being grouped in one general head by the University of Pennsylvania at West Philadelphia, as has been done at Boston in Massachusetts Institute of Technology, where an industrial art class has already attained high prominence; but this suggestion may not be open to consideration until after the school shall have secured its independent support, which we think is the case at Boston. As remarked before in this paper, the kindred arts of mechanics and architecture are associated intimately in processes and results, and it would appear that with these studies, industrial art should also be associated.

YOUNG'S WATER MAIN TAPPING MACHINE.

THIS invention has recently been the subject of several improvements. These mainly consist in the material used in the construction, the main bar being made of cast steel, and all other portions of steel or brass, thus avoiding any difficulty from springing while in operation. The two parts of the drill case A are clamped by bolts and receive the drill B. At the end nearest the pipe is a detachable washer, in a socket having a concave face to be clamped against a packing gasket in order to make a watertight joint. Instead of making this packing in two parts as formerly, it is now formed solid and a round stop cock employed, over which the packing is pulled when the machine is removed. The handle at C communicates with a cock within, to close the aperture when the drill is removed, the cock having a notch to allow of the passage of the tool. After the hole is drilled and the point of the implement drawn back beyond the cock, the latter is turned so as to close the orifice. The connecting pipe is then substituted for the drill, the cock turned back, and the connection made. The hose at D serves to conduct away chips blown out. The drill is operated by the ratchet lever shown and fed by the screw E.

Fig. 1

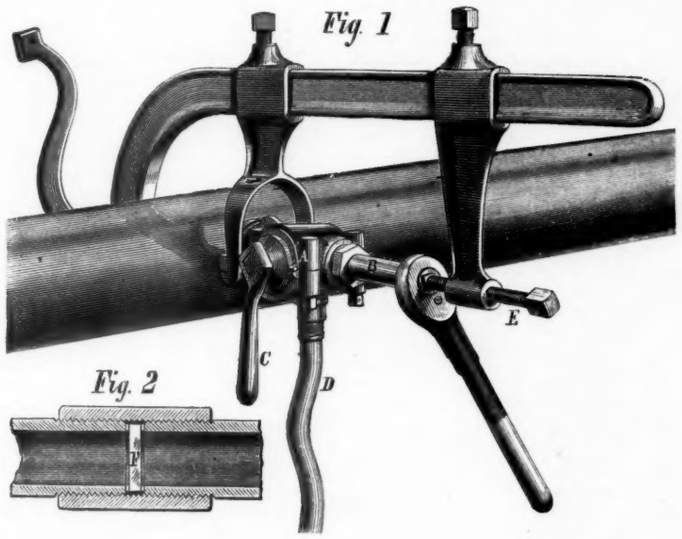

Fig. 2

The apparatus as improved may be adapted to 1, ¾, ½, and ⅜ inch pipe, by substituting different drills.

This inventor has also patented an extra improvement on his device, by which a disc of glass F, fig. 2, is substituted for the stop cock usually employed and left buried in the earth, thereby decreasing the expense and simplifying the process. For the purpose of keeping the water back while the connection is being made, the service pipe is constructed in sections coupled together by a union and having between their ends the glass plate As soon as the work is done, one of the sections is screwed up tightly, thus crushing the glass and permitting the water to flow. The pieces are, of course, quickly washed out.—*Scientific American.*

AMERICAN RAILWAY CARS.[1]

ON the afternoon of Saturday last, the limited express by the Pennsylvania Railroad, from Philadelphia, due here at 2.26 P.M., met with an accident which served to show very clearly the excellence of American car building practice. It was thrown from the track about two miles east of the city of Trenton, and, so far as could be judged from the appearance of the track and switch, the accident was caused by a broken switch stand. The engine passed over safely but displaced the rails so that the tender jumped the track, dragging after it the mail, baggage, and two of the drawing-room cars. Crossing one or two tracks, the cars struck a coal train standing on a side track, and demolished a number of the coal cars, at the same time ripping up and completely wrecking the tracks over which they passed. The road bed itself was damaged considerably, being dug up, and ties cut and torn out, so that it was necessary to lay tracks around the break. The force of the blow was so severe that the ends of both the baggage and mail cars were completely crushed and shivered. Neither mail agent nor express agent in these cars received any injury, however. The two palace cars following, which left the track, were uninjured, save that one of them had a platform broken; the car itself, however, was intact. The coal cars which were struck by the train were completely demolished. The tender, which was wrenched from the engine by the shock, was also destroyed. The distance run was very short, as the engineer put on the brakes before the tender went down. The time in which the power had to act was of course very short, but as the parting of the couplings does not throw the brakes off, they continued their effect until the train stopped. The train was a fast one, and running at a high rate of speed (not much under the rate of forty miles per hour at the time), and with the exception of the baggage and mail cars, it was made up of heavy Pullman drawing-room cars. The weight of that part of the train that left the track, with that which did not, could not have been less than 460,000 pounds. Great surprise has been

[1] From the "Iron Age," New York, Nov. 18, 1875.

expressed that no one was hurt, and that so little injury was done to the train. When the construction of these cars is considered, it is nothing to be surprised at, their behaviour under the circumstances being what would be expected. The tender, being short, heavily loaded, and by no means as strongly built as a passenger car, was destroyed. Those cars that struck the coal train and rolled loose from their trucks, had their ends broken in, while in the last cars the shock was very light. Passengers remarked: "That is a very short stop;" but it was not supposed that an accident had happened. In the cars of this pattern, the amount of resistance offered by the framing is something enormous. Six sills are commonly used, beside two truss planks or their equivalents. In many cases, even more timber than this is put in. The cross section may, we think, be safely set down as about 240 square inches of the best Southern pine, whose crushing stress cannot be less than 6000 pounds per square inch, or a total of 1,440,000 pounds. In the baggage and mail cars the quantity of timber is even greater, since they are framed so as to carry heavier loads. To crush in the end of a car thus framed, as might be expected, is exceedingly difficult, as the blow comes upon the platform, and its force is seriously diminished before it reaches the car body. With a train of cars less strongly framed, the forward ones must certainly have been crushed or telescoped, and the resulting loss of life, would, of necessity, have been heavy. Recent accidents in England, of a very similar character to this one, but with trains, so far as we can learn, weighing much less, have resulted in large losses of life. The side doors necessary in compartment cars of the kind used there, are doubtless very convenient at stations, but when, through those same doors, the passenger, shot out into a mass of *débris* during an accident, finds himself a part of the general wreck, and is crushed and ground among springs, wheels, sole-plates, and panels, he would, it is safe to assert, willingly exchange the convenience, for more strength and safety. We say confidently that we do not believe it is possible to build cars with compartments and side doors that can in any way approach the strength of the long American car with end doors. The whole floor and side as far as the window sills, is a unit, and the amount of resistance which is offered is something extraordinary, when compared with the coaches used on foreign railroads.

COMBINED SLOTTING AND BORING MACHINE.

MACHINE tools employed in larger industry are usually based on the principle of the division of labour. Like the workmen who use them, they have a definite function to perform. Hence the whole structure is generally simple, and its chief value depends on the perfection with which its details are constructed, and how the trained workman applies it to its purposes. But the division of labour is unsuitable for smaller industry, on account of the narrow limits of its operations. The workman has many different tasks to perform, and consequently requires machines capable of various uses.

Messrs. Walch and Mörike, machine makers at Munich, have constructed a machine which performs the operations of slotting, boring, and polishing. The working tool of this machine may have a vertical motion up and down, and by a change in the motor can be made to have a rotatory motion, so that, according to the tool inserted, it may become a boring, polishing, or slotting machine.

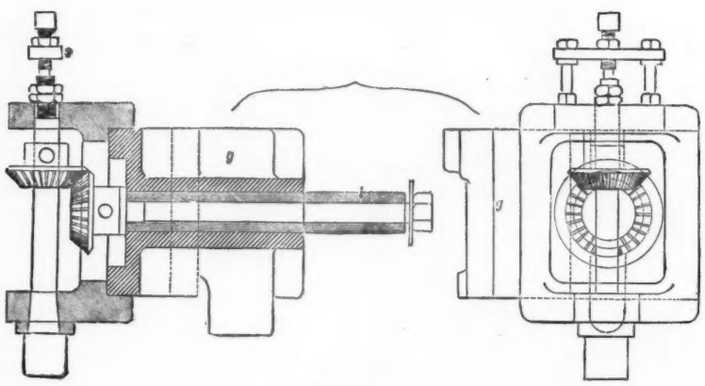

Fig. 4.

For the reception of the object to be operated on, the table is placed on its cross-support, which, in connection with a round table, renders it possible to move the object in any curve that may be desired, so that with the same machine a great number of different forms may be produced. This variety of movements is attained by means of the following construction.

The base plate *e* bears in one part the column with the driving apparatus, in another the supporting apparatus, with the work-table A, which, by means of slits, allows the extension of the object to be worked on, and for the same purpose also has a female screw in the middle for screwing in mandrels, heads, &c. This table is round, and is turned round in the usual way by an endless screw *a* in the middle of the spindle, which may be loosened so as to allow the table to move, and the table can afterwards be kept in a fixed position by the blocking apparatus *c*, which fits into the indentations in the border *b*. These indentations are arranged in a square and hexagonal division, to admit of easily shaping screws, &c.

The round table rests upon a cross support of ordinary construction. In the horizontal support *d*, two movable screws, which meet a pivot inserted in the centre of the slit, denote the length of the hole to be bored. Above the column *f* is the frame-work *g*, which forms the support of the moving beam, the transmission wheel, and the slotting or boring apparatus. A tongue and groove give the frame-work a vertical movement, two binding screws press the tongue tight into the groove, and thus fix the frame-work at any desired height. Moreover, for the purpose of fixing the height, the whole frame-work is suspended on a screw-spindle *r*, which is supported by the column, and has its female screw in a cross-piece united with the frame-work *g* by two uprights, so that the whole mechanism can easily be brought near the object to be worked on. If the machine is to be used for boring, the two binding screws are only slightly screwed up, so that the screw spindle *r*, which is furnished with a small hand-wheel, can be employed for the purpose.

The machine is set in motion by a hand-winch attached to a fly-wheel, and the motion is transferred by a changeable transmission apparatus to the main axis *i*, which, being hollow, receives the axis *m*, variable so as to be adapted for the slotting and boring apparatus. The change of transmission is effected by the shifting of the pair of wheels on the axis *i*, which are fastened sideways by the upright *l*. The second pair of wheels, together with the fly-wheel, are attached to the hollow axle *i*, which turns round the pivot inserted in the frame-work *g*. This pivot is inserted eccentrically, so that a slight turn of it moves the two pairs of wheels nearer to or further from each other, and thus brings about an exact adjustment.

If the machine is to be used for boring or polishing, an axis *m* is inserted in the hollow axle *i*, and revolves with it, and has at the end a bevel wheel which turns the boring spindle, also having a bevel wheel. The boring spindle, with its bevel wheel and cylindrical pivot, is inserted in a frame which is screwed on to the front plate of the frame-work *g* with four screws. The boring spindle can be exactly adjusted by female screw and

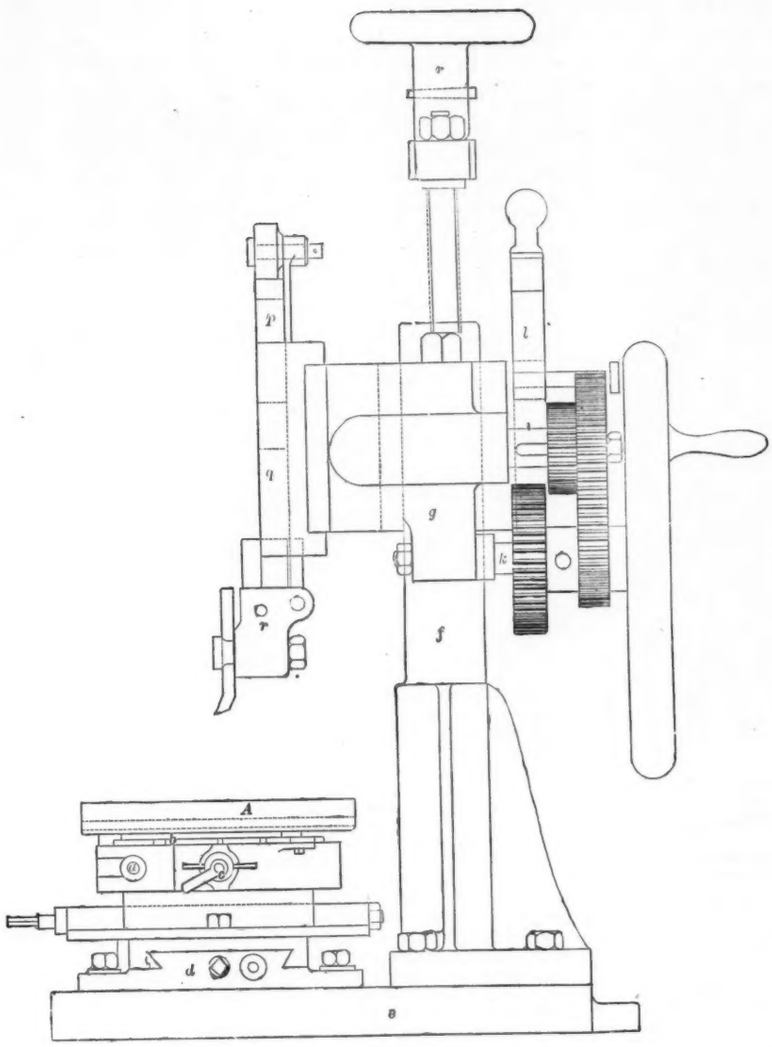

Fig. 1.

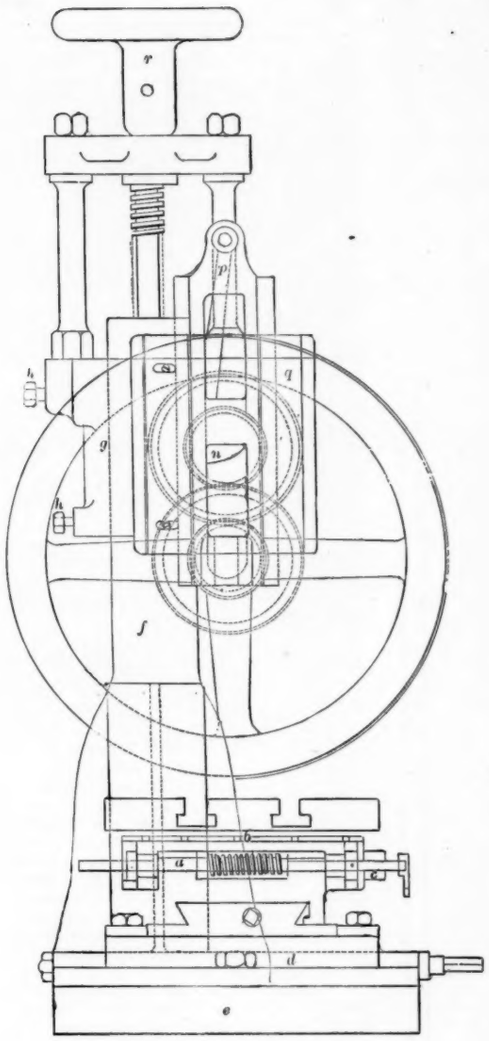

Fig. 2.

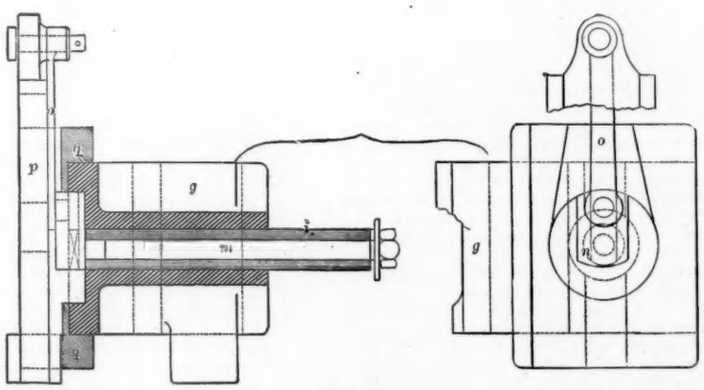

Fig. 3.

COMBINED SLOTTING AND BORING MACHINE.

jam nut, and a binding screw *s*. The working of the borer can be effected by the spindle *r*, as stated above.

If the machine is to be converted to a slotting machine, the boring frame must first be removed, and the axis *m* replaced by another having at its head the winch *n*. The range of this winch is rendered variable by an opening behind it, in which a sliding piece of the axis *m* can be moved and fastened. The winch *n* is brought into connection with the slide *p* by the rod *o*, and the turning pivot of the rod is simply inserted in the corresponding hole of the winch. Lastly, this slide *p* has at its lower extremity the tool-head *r*. The frame *q*, in which the slide moves, is, like the corresponding frame of the boring machine, screwed on to the front plate of the frame-work *g* with four screws.

The tool-holder *r*, at the lower end of the slide *p*, can be turned round so as to take any desired position. Moreover, when the slide goes upwards, the chisel can be moved back, so as to keep its edge from contact with the slide.

The machines, with their present dimensions, work objects in wrought or cast iron, steel, or other metal, 60 millimetres (2¼ in.) thick, and 200 millimetres (7⅞ in.) long, or, converted to boring-machines, make holes 25 millimetres (nearly an inch) in diameter, and 60 millimetres (2¼ in.) in depth. They also make wedge-grooves, slits in boring-rods, &c., 18 millimetres (about three-quarters of an inch) broad, and 200 millimetres (7⅞ in.) long. By means of the round support circular grooves and slits can easily be made. As the changing of the machines for their various purposes takes little time, they are well suited for performing many smaller industrial operations, which are much more troublesome and tedious when done by hand. *Bayerisches Industrie-und-Gewerbe Blatt.*

A NEW SUBSTITUTE FOR WOOD-CARVING.

CARVED work is one of the most ancient forms of expressing a refined taste, and its examples are to be found in every age and among every people. Even the rudest of communities afford many exquisite illustrations of human skill, and upon its elaborate specimens great sums have been expended. The popularisation of art, which has been the characteristic of society during the last thirty years, has induced many attempts to imitate the sculptured hand-work of the artificer, by means of casting and colouring; but public taste and the voice of authority has condemned them on the ground of their unreal nature and their liability to accidents which exposed their inherent worthlessness.

We have had the opportunity of inspecting the examples of a new process for the reproduction of wood-carvings, and believe it will become valuable and popular. The secret must necessarily lie in the preparatory treatment of the wood, and the power of obtaining an enormous pressure. The inventor and patentee, Mr. Ley, requires about 1,500 tons force by means of hydraulic pressure on cut steel dies in order to execute large works of art in relievo to the depth of one inch. The possibility of obtaining this he has demonstrated in the examples on view at 43, Hart Street, Bloomsbury, one of them in particular has actually that depth. Those productions illustrate what can be done, and it will not be long before the invention obtains a prominent position in the decorative arts. Especially is it adapted for panels, pilasters, friezes, centres, medallions, mouldings, borders, or ornamentations proper to every style that can be used in quantities; because, in most cases, the cost of reproduction is about a tithe of the outlay required for hand-work. In truth hand-work, from its costliness, never can obtain a general demand, and from that very circumstance it is evident that this discovery opens a new chapter in the history of taste as applied to the adornment of dwellings without interfering with the venerable art of the artificer in wood. In fact the *bois repoussé* work, as it is termed, must come to be an incentive to the ancient method by diffusing taste and thereby increasing a demand. Then, again, for the business of the cabinet maker it cannot but become a most important auxiliary. Household furniture ornamented by its agency is beautiful and true. It is wood, and not an imitation. We can have it employed on walnut, mahogany, oak, or, indeed, any of the woods commonly in use by the trade; the variety in style, size, and material included within its power involve an assurance of its ultimate and profitable popularity. It is not a sham, and has therefore a claim for durability and solidity which has never been possessed by any previous discovery; and, moreover, the grain of the wood being horizontal, in contradistinction to an American device which could give the pattern only upon the end grain of the wood—an obviously false principle—gives the work exactly the same appearance as if produced by the wood carver.

For the innumerable elegancies of the boudoir and drawing-room essential in modern residences, such as desks, cabinets, frames, carved bellows—so much known in ancient times—platters, and in fact almost every form of artistic taste, whether mediæval or modern, this invention opens up what is practically a new industry.

The grand old bookbinding, in which the carved wood cover was a most distinguished feature, can now be reproduced in all its integrity by an additional new process for producing dies so terribly expensive by hand labour, in absolute facsimile of the most elaborate and, to us, classical models.

BOILER FLUES.

QUOTING from the "Scientific American," the "Nautical Gazette," of New York, gives the following notice:—

"The National Tube Works Company, of Mc Keesport, Pa., says the "Times," are now manufacturing wrought iron lap-welded tubes in all sizes up to fifteen inches diameter, the larger of which are now being adopted on our steamboats for boiler flues, instead of the riveted flues, and the following steamers are now using them for this purpose: Steamer "Vince Shinkle," two boilers, forty-seven inches diameter and twenty-four feet long, ten lap-welded flues in each, of eight inches diameter; steamer "Cons Miller," two boilers, forty-one inches diameter, twenty-four feet long, with six lap-welded flues in each, of ten inches diameter; steamer "Golden Rule," three boilers, forty-four inches diameter, twenty-six feet long, with three eight and three ten-inch lap-welded flues in each. These tubes are giving perfect satisfaction, and the local inspector at Cincinnati says that they have proved themselves all that could be desired. There are many advantages claimed for these tubes, as flues, among which we might mention the following: They are cylindrical in form, a point not claimed for the riveted flue, thereby lessening the chances of collapsing, if not absolutely preventing accidents of this kind. There are no rivet heads or laps to interfere with the draught, and, consequently, the flues are not liable to choke up with soot, are much less apt to scale, and, having a smooth, unbroken surface, are, of course, much more easily cleaned, a fact that will be appreciated by the firemen. Another point claimed is that they are of uniform gauge, having no rivets or laps, and must naturally require much less fuel, a fact that will undoubtedly receive due consideration."

These lap-welded boiler flues are made with a view to supersede the commonly used riveted flue in boiler work. They are made from the best charcoal hammered iron, with great care and exactness, combining greater strength and symmetry, and possessing, also, the merit of having a greater heating surface than the riveted flue; for instance, a 12-in. lap-welded flue is equal in area to a 13-in. riveted one, and so proportionately, on all diameters. These flues are made up to fourteen inches outside diameter, in lengths of sixteen feet and over, and from No. 1 up to No. 12 gauge.

DENAYROUZE'S AEROPHORES.

ON a previous occasion (p. 50) we gave a brief account of M. Denayrouze's invention for the use of miners and divers, to which he has given the name of *aerophore*, *i.e.* air-bearer, and for which he obtained a prize from the French Academy of Sciences. Aerophores are divided into two classes, according as they are of high or low pressure, but the same principles are observed in the construction of the apparatus in both cases. The requirements are to give the workman who has to enter an atmosphere unfit for respiration a sufficient provision of pure air; to enable him to remain in it for a varied length of time without danger; to enable him to breathe this pure air under a pressure differing as little as possible from that of the ordinary atmosphere; to make a portable and convenient apparatus which will interfere with his work as little as possible; to furnish him at the same time with a useful light secured against all chance of explosion; and lastly, to make the operations and apparatus simple enough for speedy use.

The necessity of storing a considerable quantity of air with small volume leads to the use of pumps, which we proceed

DENAYROUZE'S AEROPHORES.

to describe. The air-pump, usually employed, and represented in our first figure, gives, with a few strokes of the piston, a pressure of 3 to 4 atmospheres, indicated by a manometer, and is capable of sending out 80 to 100 litres (17½ to 22 galls.) of air at the rate of 35 to 40 strokes of the piston. It is distinguished from others: first, by the arrangement of the body of the pump and the pistons, the former being movable and the latter fixed, contrary to the usual plan; secondly, by the use of hydraulic closing, formed by a layer of water interposed above the valves, so as to render all escape impossible and get rid of vacant spaces, while taking from the air the heat produced by compression. During the alternate movement of the balance,

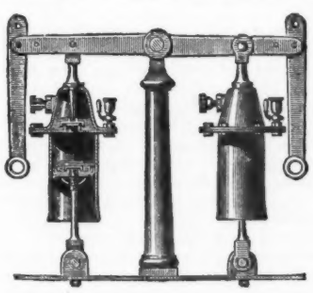

Fig. 1.

the air penetrates through the piston-valve when the body of the pump is raised, passes through the layer of water, is compressed when the body of the pump is lowered, lifts the piston-valve, and passes through a new layer of water into the cap at the top of the body of the pump. Thence it is distributed, with whatever pressure is thought suitable, by means of a tap and conducting tubes. The usual dimensions of this pump are 100 millimetres (nearly 4 inches) for the diameter of the pistons, and 180 millimetres (7 in.) for their stroke. It serves for low-pressure apparatus.

When it is necessary to use high-pressure apparatus, the compensator-compressor, represented in fig. 3, is employed. This is a pump with fixed pistons and moveable body, to which the same principle of hydraulic closing is applied. To produce the most powerful effects (pressures of 20 to 25 atmospheres) atmospheric air is taken by the first pump, and shut up in a first reservoir, of a capacity calculated in such a way that the pressure there continues to be that of four atmospheres. This air, already compressed, is then sucked in through a second smaller piston, and passes into a reservoir one-sixth of the size of the first, where its pressure becomes that of 24 atmospheres.

The two pistons are fastened on a cast-iron plate by screws

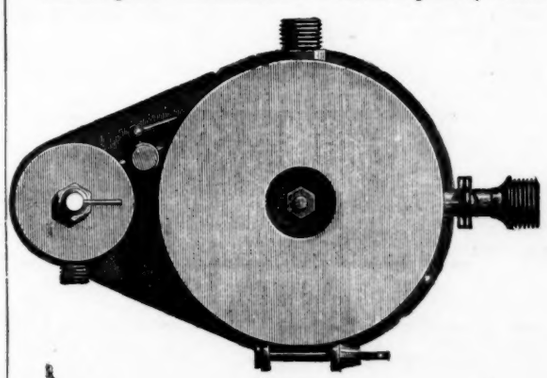

Fig. 2.

and nuts. Both have stuffing and hot-pressed leather. Water is let in from a vessel with a tap when the suction takes place. The presence of the liquid has three advantages: the prevention of escapes, the cooling of the body of the pump and the air, and the suppression of vacant space. A double-bodied compressor, compact and manageable, will in eight or ten minutes fill a reservoir of 20 litres (4½ gallons) in capacity, with air having a pressure of 25 atmospheres.

The air, having been compressed, should be placed at the miner's disposal, with a pressure as near as possible to that of the ordinary atmosphere. This result is obtained by means of

the regulator, fig. 2. This is composed of two drums of different dimensions, the larger one being intended for the workman's use, and the smaller for supporting the combustion of the lamp. The section of the apparatus, fig. 4, shows the two reservoirs below for the reception of the compressed air, which are in constant communication. Above are the air chambers, closed above by a metallic plate of a diameter rather less than that of the chamber. This plate is covered with an elastic india-rubber lid, the edges of which turn down over the sides of the chamber and hermetically close it. The larger chamber serves for respiration, the smaller for lighting.

The plate and the india-rubber lid are capable of yielding to pressure either from without or within, and consequently of sinking or rising. The former movement causes the opening of the conical valve between the reservoir and the air chamber, the latter closes it.

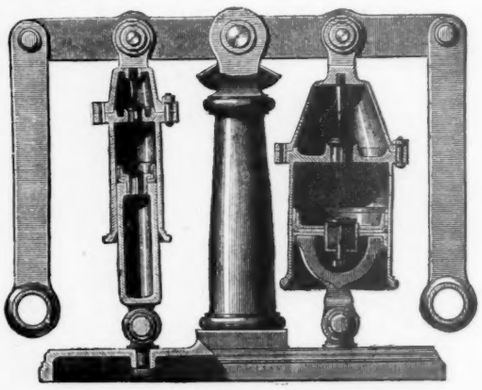

Fig. 3.

The inspiration and expiration of air are accomplished by means of valves, composed of thin pieces of india-rubber, which stick together simply under the external pressure. They are placed in a contrary way on the tube which goes from the regulator to the mouth. In inspiration the valve attached to the regulator opens, and the other closes; in expiration the opposite movement is produced by the excess of pressure in the tube. A mouth-closer, placed between the lips and the teeth, receives at its centre the extremity of the inspiration tube, and ensures the admission of air into the miner's mouth. These arrangements are completed by the use of a purifier composed of a felt disc between two hollow bronze hemispheres, specially adapted to keep off the coal dust which might obstruct the valves of the regulator during the filling of the apparatus.

The difficulty of lighting in mines with fire-damp in them is overcome by feeding the combustion of the flame with pure air

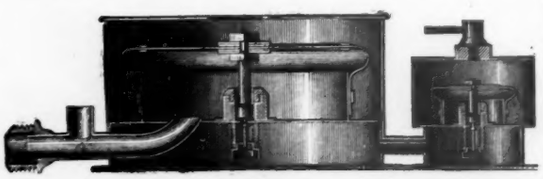

Fig. 4.

from the regulator. The lamp is simply an ordinary safety lamp, modified so as: 1. to give admission to more or less air by means of a tube with a longitudinal opening; 2. to convey the air to a reservoir below the wick, whence it escapes through a number of small holes in the circumference; 3. to close the chimney of the lamp by a small ventilator-valve which is raised by the current of hot gases produced by combustion, without explosive mixtures being allowed to enter. Numerous experiments have proved that the lamp, thus modified and fed, is capable of burning, for an indefinite period, in the most dangerous atmospheres without causing the least inconvenience.

In the simplest cases, when the workman has to go only a short distance in an atmosphere unfit for respiration—say, 10, 20, or 30 yards—nothing more is required than a simple tube with the system of inspiration and expiration valves described above. One end of the tube is in the open air, the other terminates in the mouth-closer, and the workman thus breathes a pure air without the least inconvenience. A nose-pincher prevents the introduction of dangerous gases.

In ordinary cases the miner can carry on his back the breathing regulator which receives the air directly from the air-pump worked at a distance. A vest, fastened round the waist and chest by buckles, supports the regulator, spreads the pressure equally over the whole bust, and does not impede the movements of the workman.

Lastly, when the miner has to penetrate deeply, to remain a long time, and light himself in a dangerous gallery, he is furnished with the two-ended regulator, and takes with him on a truck a provision of air, previously compressed to 25 atmospheres. The six reservoirs have each a capacity of 4½ gallons, and suffice to support the man's respiration and the combustion of the lamp for more than two hours and a half. At the end of that time the provision of air is simply renewed by a workman who brings a number of fresh reservoirs, and urgent operations are carried on without the least interruption.

An advantageous application of this apparatus has been made to military purposes in undermining. The aerophore can be modified so as to consist of three cylinders, the total volume of which does not exceed that of a soldier's knapsack. The middle cylinder has a regulator for distribution, connected by a tube with the miner's mouth. A small disc worked by the hand allows the bearer of the apparatus himself to increase the quantity of air necessary for respiration by lowering the valve with a spring. This portable apparatus, which was favourably received by the Prussian army two years ago, is now adopted in France. It has also been tried with success in various German and French mines. *Revue Industrielle, Feb.* 2, 1876.

STEAM FERRIES FOR WIDE RIVERS.

THE steam ferry shortly to be opened across the Thames from Wapping to Rotherhithe is one of the remedies proposed for the enormous congestion of traffic near and over London Bridge. Another bridge lower down the river, whether on a high or a low level, would be attended with difficulties so numerous and so gigantic as to be well nigh insuperable,* and therefore attention is at present directed more especially to the widening and improvement of the present bridge. The Tower Subway, from Tower Hill to Tooley Street, is a small affair, available only for foot passengers, who have to descend and ascend inconvenient corkscrew staircases at the two ends. The Thames Tunnel is converted into a railway, and is henceforth available only for railway traffic. Hence the scheme for a steam ferry *on* the water instead of a subway or tunnel *under* it. What such a ferry implies we do not yet fully know in regard to the Thames; but a sufficiently clear idea may be formed by watching what has been done in other quarters.

Portsmouth is just one of the towns at which a floating bridge or steam ferry is likely to be useful. Between that busy place and Gosport is a narrow deep channel, expanding northward into a fine harbour and southward into the open sea. No bridge of ordinary construction could be permitted there, because lofty-masted ships are repeatedly passing through the channel into and out of the harbour. The traffic between Portsmouth and Gosport used to be carried on by means of ferry boats and other row boats; but this agency being insufficient as trade increased, Mr. Rendel, the engineer, was requested to devise something more effective. A steamer can easily be built, with a deck sufficiently long and broad to sustain carts, waggons, and horses as well as passengers; but if driven ever so little out of its straight course by currents, tides, or winds, such a vessel would with difficulty reach the exact landing spot designed. Hence the necessity for means of guidance as well as means of propulsion. Mr. Rendel planned a flat-bottomed vessel, 50 ft. long by nearly as much in width, with two platforms near the sides for carriages, and a central compartment for foot passengers and for engineering appliances. At each end was a hinged platform which, when lowered to the proper angle, formed a gangway from the vessel to a beach properly trimmed to support one end of it. Two long chains were stretched from side to side of the harbour, dipping down deeply into the water. In the middle of the vessel was a steam-engine, working two vertical wheels 7 or 8 feet in diameter. The axes of these wheels being at right angles to the length of the vessel, the chains were enabled to pass over the peripheries, which were provided with depressions and protuber-

* The most recent project of this kind, however, is so remarkable in some of its features, that we shall probably take an early opportunity of describing it.

ances to accommodate the links of the chains. Both chains were firmly fixed at the shore ends, but in the centre they dipped down so deeply into the water as to allow the heaviest ship to pass over them; they were carried through the vessel and over the peripheries of the vertical wheels, the cogs or protuberances of which fitted into the links. This being the mutual relation of the vessel and the chains, and the vertical wheels being set revolving by the action of the steam-engine, it is evident that one of two results must follow—either the vessel will drag the chains out of the water, or the chains will drag the vessel along. The former could not occur, because the chains were firmly fixed at the shore ends. The links of the chains were caught in succession by the cogs or projections on the circumference of the wheels, and thus the wheels and the vessel that contained them were pulled across the entrance of the harbour from a spot near the Gun Wharf at Portsmouth to the opposite shore at Gosport. When the vessel was near the middle of its passage, the free part of each chain hung down in two festoons, each dipping deeply enough into the water to allow ships to pass over it. The primary purpose of the chains was in this way to direct or guide the vessel across the channel from east to west and *vice versâ;* but they also prevented it from swaying to and fro laterally under the influence of winds, tides, and currents. The two ends of the vessel being exactly alike, she could steam equally well in both directions. The hinged platforms at the ends were so regulated in length that horses and vehicles could easily enter the vessel at one shore and land at the other. These platforms were lifted up somewhat by chains (or rather the extreme end of each was lifted up) during the passage of the vessel across the channel.

The above description we have given in the past tense, in order the better to convey a notion of Mr. Rendel's original plan. It suffices here to add that the practical details of the scheme were substantially adhered to, and that this mode of crossing Portsmouth harbour has been usefully adopted ever since. Plymouth copied the example set by Portsmouth; a floating bridge having been established across the Hamoaze, from the Devon shore on the east to the Cornwall shore on the west. Other rivers and estuaries have since been similarly provided.

In the year 1873 the Birkenhead Commissioners formed a project for a new ferry from that busy port to Liverpool; or rather invited plans from experienced engineers, preparatory to accepting the best that might be proposed. The traffic between the two places is immense; passengers, horses, light vehicles, heavily-laden carts and trollies, are crossing the wide Mersey all day long. Notwithstanding the improvements in the great docks and the magnificent landing-stage at Liverpool, the means of transit are still insufficient. It is a wide stretch of deep water to be called a ferry, but the traffic is just of the character denoted by that term. Many plans were forwarded in response to the applications of the commissioners; the first prize was given to Mr. Knox and Mr. Schlesinger of Newcastle-on-Tyne—the one a civil engineer and the other a shipbuilder—for the combination which appeared best suited to the requirements of the case.

The two chief features of this plan relate (1) to the landing-stage arrangements at the two sides of the river; and (2) the vessels that are to make the passage to and fro. The existing landing-stages are six feet above the level of the water, and as that proportion is not to be altered in the establishment of the new ferry, all the details of the plan are made in conformity with it. There are to be two vessels, to keep up a series of passages to and fro. The deck, arranged for the reception of foot-passengers, vehicles, cattle, merchandise, and luggage, will present as much clear space as possible for their accommodation. Each vessel will be 150 ft. extreme length, 48 ft. beam over the paddle-boxes, with 7 ft. maximum draught of water; the engines, of 120 nominal horse-power, will insure a speed of 10 knots an hour with a load of 100 tons. No part of the machinery projects above the level of the deck, except cranks and eccentrics, and these will be boxed off within a compact wooden house, the top of which forms part of the bridge, and at the same time supports the hydraulic steering gear. This house, two cranes, and two small hatchways, constitute the only obstructions on deck, all the rest being clear and level space. There are openings in the bulwarks at the sides and ends to receive the gangways for embarking and disembarking; the bridge on which the captain stands while the vessel is in motion, can, when it is stationary at the landing-stage, be raised by hydraulic power, to admit vehicles laden to a considerable height in their passage to a proper station on deck, and then lowered again. The tiller, anchor-gear, &c., are all below deck; pens for cattle and sheep are easily and quickly fitted up on deck, by rails and stanchions placed near or far apart, according to the number of animals to be accommodated. The vessel being alike at the two ends can be steered either end foremost, thereby obviating the necessity of turning on the to-and-fro trips. The deck is formed of stout pine planking, supported by iron beams, stringers, and stanchions; the engines, which work two paddle-wheels 16 ft. in diameter, are started and reversed from the bridge by hydraulic power. Small double-cylinder engines, provided with Tweddall's steam-cylinder accumulator, supply the power for working two hydraulic cranes on deck, placed fore and aft of the engine room, and for other purposes connected with the working of the vessel.

The landing-stage on each shore is to be provided with a semi-embayment for the convenient drawing up of the vessel. The approach will be divided into ingress and egress ways, with cast-iron kerbs and chequered rolled-plate wheel-ways; between these will be the horse-ways, formed of rounded hard timber with flat wrought-iron bars let into the top. Access from the stage to the vessel will be provided by means of large lifting gangways of iron and timber, with kerbs, wheel-ways, and horse-ways corresponding with those on the stage itself. The lifting of this gangway to its proper position will be effected by two hydraulic rams, placed within ornamental cast-iron columns on the landing-stage; lifting chains, passing over pulleys, are attached to the outer sides of the main girders that support the gangway. Well-arranged warehouses and docks form component elements in this place; but we need not notice them here, as our subject is the ferry vessel itself, and the arrangements at the two landing-stages for its reception.

The destruction of the grand landing-stage at Liverpool by fire, and improvements introduced in its reconstruction, may have delayed or modified the adoption of this ingenious ferry scheme; but the scheme itself is worthy of attention in relation to the proposed ferry across the Thames.

The ferry now in progress, and shortly to be opened for public traffic, appears to have originated with Mr. Edward Sewell Bulmer, a city merchant; that is, not the engineering and mechanical details, but the official and commercial preliminaries, which were neither few nor unimportant. He had to obtain the sanction of the Corporation of London, the Board of Conservancy of the Thames, the dock companies, and the owners of such wharf and quay property as he might require; he had also to ascertain whether wholesale dealers and retail traders would be likely to avail themselves of such a mode of conveying merchandise across the Thames. The spot selected by him is close to the Thames Tunnel—nearly over it—from Tunnel Wharf and Londonderry Wharf, at Wapping, to Church Stairs Wharf, near the Commercial Dock. Although the straight line distance is only a little more than a mile and a half below London Bridge, the road distance, through the narrow and crooked thoroughfares that lead to Wapping and Rotherhithe, is nearly two miles; and there is a fair probability that buyers and sellers will be willing to pay a reasonable toll for the use of the steam ferry if, by so doing, they can save from two to four miles of tedious land transport through ill-arranged and over-crowded thoroughfares.

On the Wapping side of the river will be a large block of warehouses five stories in height, provided with hydraulic power, a steam engine, and an accumulator, with a ram 20 in. in diameter, with a 22-ft. rise. These warehouses are not a necessary part of the ferry itself, but will assist in developing the trade created by it. A wharf between the warehouses and the river will be provided with a substantial river wall. A landing-stage will project outward from the wharf 100 ft. into (or rather over) the river. This stage, 22 ft. wide at one end, and expanding to 36 ft. at the other, will be made of wrought iron, with oak decking, and a gangway for foot-passengers railed off on both sides. It will be supported on cast-iron columns, varying from 3 ft. to 5½ ft. in diameter, screwed down 16 ft. into the bed of the river, and then filled in with concrete. (The ceremony in which the Lord Mayor took part last October consisted in giving the final turn to the first of these screwed cylinders.) Outside the landing-stage, towards the river, will be a hydraulic platform, 70 ft. by 36 ft., with the inner edge nearly close to the stage. Two powerful hydraulic rams on each side of the platform, coupled and connected to work simultaneously, will keep the platform horizontal even if unequally laden. By other hydraulic action, derived from the shore, the platform will have a vertical rise and fall of 20 ft., the highest level being that of the landing-stage, the lowest that of the steam ferry-boat. The platform is made of wrought iron, decked with wood.

So much for the shore arrangements, which will be pretty nearly the same at Rotherhithe as at Wapping. We have now to consider the transit arrangements. The steamboat (of which two or more will be used, according to the extent of the traffic) is square-ended, so as to come up close to the landing-stage, and it is about 83 ft. long by 42 ft. wide over the paddle-boxes. It will accommodate twelve pair-horse waggons or

carts, in three parallel lines of four each, with a footway for passengers on each side. The steam engine, of 30-horse power, is so adjusted that the vessel can be turned on its centre if necessary, which, however, is not generally intended to be the case. Dolphins will keep the boat in place while drawn up at the platform. The level of the landing-stage is at about 8 ft. above Trinity high-water mark, and therefore the descent of the platform depends on the state of the tide at the time of making each trip across the river. The side footways on the boat, for the better convenience and comfort of passengers, are raised above the level of the waggon-ways; these footways are each 7½ ft. wide, while the clear width for the three lines of waggon-ways is 27 ft.

A sufficient reason presents itself why the platform cannot, as at Portsmouth and Plymouth, be allowed to form a descending gradient from the level of the stage to that of the boat. The narrowness and crowded state of the Thames would not allow the platform to extend far enough out into the river for this purpose. In order that the platform may be compact, and of moderate dimensions, it will rise and fall vertically from the level of the stage to that of the boat, and *vice versâ*. Supposing a laden cart to be about to cross the river, it will be drawn by its horse or horses from the quay to the landing-stage and the hydraulic platform, all three on the same horizontal level; when the platform has been filled, or sufficiently filled, with its load of vehicles and passengers, it will be lowered by hydraulic power to the level of the boat, and, the gangways of the latter being opened, the vehicles and passengers will pass from the platform to the boat. The transit across the river will be by steam power in the usual way. Arrived at the other shore of the Thames, the landing will be effected by a reversal of the several operations.

The extent of the appliances provided will depend on that of the traffic to be accommodated; but according to the plan on which the company is proceeding, there will at first be two boats employed, so timed as to provide quarter-hour trips in each direction. One or two more boats will be added if the traffic demands it. Numerous minor but still important considerations have had to be held in view; and they seem to have obtained the best attention of Mr. F. E. Duckham, engineer to the "Thames Steam Ferry Company," the name assumed by the directors and shareholders of this new undertaking.

The directors have had, in some sense, to take the public into council. They have had to determine, not merely what tolls would suffice if the ferry boats were pretty well filled, but whether traders would be willing to pay those tolls for the sake of avoiding the long detour by way of London Bridge; and this could only be ascertained by inquiries addressed to mercantile firms. Resulting from these investigations a provisional tariff was drawn up. According to this, the toll for a vehicle will vary from 8*d.* to 3*s.* 9*d.*, according to the number of horses and the weight of the load; a barrow or truck, 2*d.*; a cab, 8*d.*; a carriage, 1*s.*; an omnibus with two horses 1*s.* *plus* 1*d.* for each passenger; a horse and rider or a led horse, 6*d.*; cattle, 3*d.* per head; and foot passengers, 1*d.* each. How far these and other matters will be modified in practice, we shall probably know before any long time has expired.

IMPROVED TOOLS FOR THREADING BOLTS AND NUTS.

THE accompanying engravings represent improved machinery and tools for bolt-cutting and nut-tapping, manufactured by the Pratt and Whitney Company, of Hartford, Conn. The series of new machines lately introduced by this firm comprehends power and hand bolt cutters, die stocks, adjustable tap wrenches, and taps, adapted to the use of jewellers, machinists, bridge builders, mill owners, steam and gas pipe fitters, manufacturers of agricultural machines, sewing machine makers, gun makers, carriage builders, and all others requiring bolt-cutting and tapping implements.

The large engraving, fig. 1, represents what is designated as the No. 3 bolt cutter, driven by power, and having a range for bolts from $\frac{5}{16}$ in. to 1 in. diameter, and of nuts of corresponding sizes. The head spindle is hollow, and is furnished at the front end with a chuck for securing the bolt to be cut, or for holding a tap. The spindle is driven by a three-graded cone, the arbor of which connects with the spindle by gears. The chasers forming the dies are held in collets (fig. 2), four in each, and secured in radial slots in the collets by screws, permitting their accurate adjustment. These collets are seated in holes for their reception on a revolving cylinder, mounted on a sliding carriage, that is moved on the ways of the bed of the machine by hand wheel, rack, and pinion, as may be seen by reference to the engraving. The cylinder holds on its periphery nine of these collets, and a plate with different sized perforated recesses for holding square and other nuts for tapping. This plate is shown as presented to the chuck. One plate may be slipped out and replaced by another, with different recesses, instantly. By removing a collet opposite the one that is at work, a bolt may be threaded to any distance desired. The cylinder containing the collets and the nut vise is instantly brought to the bolt, or the tap, by means of the hand wheel, and the cylinder is held in position on its centre by a simple spring bolt. The threading of the bolt or the tapping of the nut is completed at one operation, the die or the tap cutting a perfectly full thread (without raising or squeezing), fully equal, it is claimed, to that produced on a screw-cutting lathe. The collets may be instantly removed, and may be replaced by hollow mills for pointing the end, turning the body, or squaring under the head of the bolt; and the bolt may then be threaded without removing it from the chuck. The hollow spindle allows bolts of any length to be threaded, and the geared head and three-graded cone give great power and a sufficient range of speeds. The chasers or cutters in the collets are sharpened, when dulled, simply by grinding on an ordinary grindstone; and any one of them may be duplicated, when broken, without the necessity of replacing the entire set. The machine is economical in the use of oil, as all the chips and oil are received into the hollow bed, and the oil drains through a strainer into a receiver, from which it may be drawn to be again used. The countershaft is furnished with F. A. Pratt's patent reversing clutch, which works with ease and certainty, and without jar or strain; and this, with the nut-tapping apparatus and case-hardened wrenches, is sent as a part of the machine.

A larger machine, similar in construction and operation, has

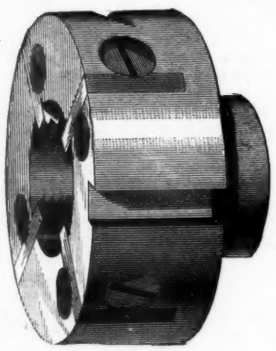

Fig. 2.

a range for threading bolts from $\frac{1}{2}$ in. to 1½ in. in diameter. This is known as the No. 4 bolt cutter. Two others are built, intended for hand work, known as No. 1 and No. 2, having respectively a range of $\frac{1}{4}$ to $\frac{3}{4}$ of an inch and $\frac{3}{8}$ to 1 inch diameters of bolts and taps. The company also build an open die machine, having a capacity of $\frac{3}{4}$ to 1 in. bolts, the dies of which are instantly opened, either by hand or automatically, to allow the bolt, when threaded, to be at once withdrawn, thus saving the time spent in running the bolt back through the die. The dies may be instantly interchanged for the different sizes of bolts without absorbing any time in adjustment.

The other engravings show a die stock, fig. 3, with the collet, and an adjustable tap wrench, fig. 4. The die stocks are made of five sizes, capable of cutting from $\frac{1}{16}$ to 1½ in. diameter, and Nos. 2, 3, and 4 may be fitted with dies for threading gas pipes of all the sizes up to and including 1½ in. pipe. These die stocks are drop-forged, in a single piece, from the toughest wrought iron, finished, and then case-hardened. The collets are held in place in the stock by spring bolts, which, when thrown back by the thumbs, permit the collet to drop out, to be replaced by another for a different size of bolt. The chasers, as may be seen by reference to the engraving, are seated in radial recesses in the collets, and are held and adjusted by screws.

The tap wrench, fig. 3, is also drop forged, of the best iron, finished, and carefully case-hardened. It is made of four sizes, to fit the shanks of taps up to 1½ in. There are two jaws seated in the body of the wrench, which are opened and closed by the thumb moving a cam disc, and held in position by a spring pawl. They hold the tap securely, preventing the danger of cramping and breaking the tap in using.

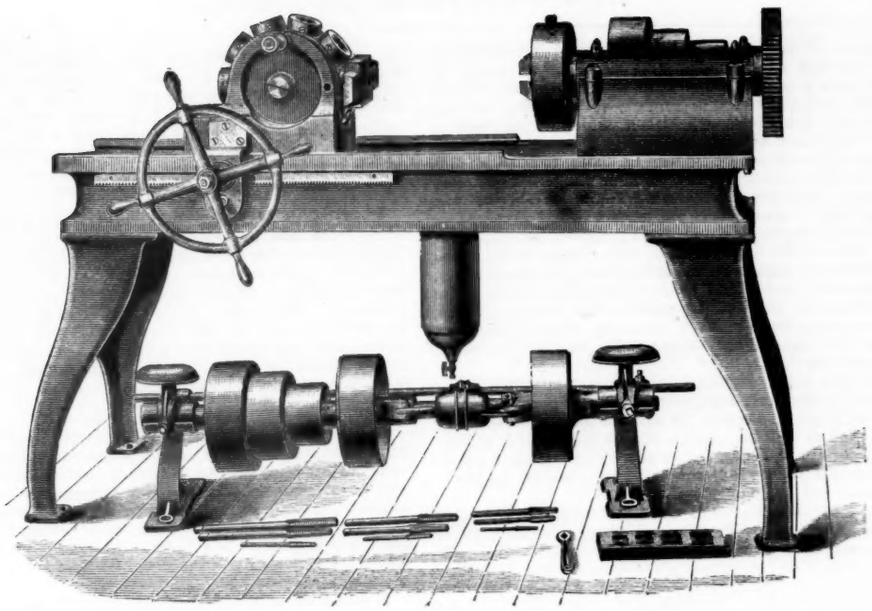

Fig. 1.

Fig. 3.

Fig. 4.

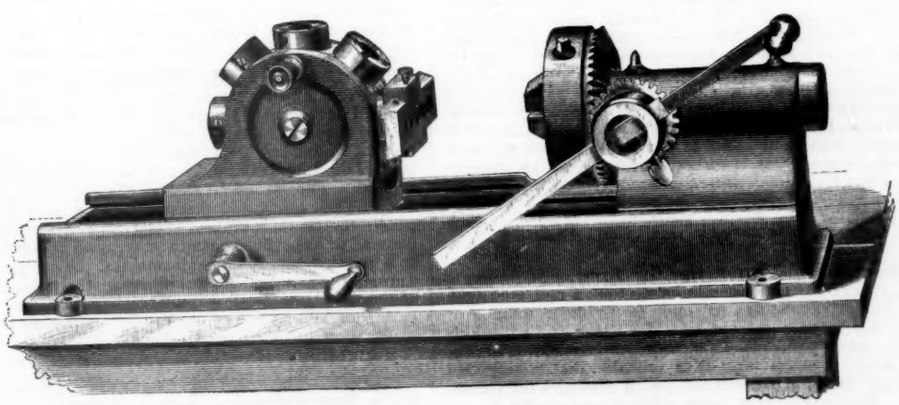

Fig. 5.

IMPROVED TOOLS FOR THREADING BOLTS AND NUTS.

The threads of the taps and dies are cut to the Whitworth thread. The taps are threaded and fluted before being relieved; the only way, it is claimed, in which they can be, with certainty, finished accurately to gauge. In replacing one tap for another, or in duplicating a chaser, a perfect *facsimile* is assured, as the gauges by which each piece is finished are themselves duplicated, one set being kept on hand, to be used only for verifying the accuracy of the working gauge. The manufacturers have the reputation of using the best quality of steel in the taps and chasers, which are hardened and tempered in the most careful manner. Every piece is thoroughly inspected, and none with visible imperfections are allowed to leave the works. The workmanship on these tools, the company affirm, is of the best, and they intend to insure entire accuracy in the sizes of the taps and dies, and the grades of the threads; so that the purchaser may be certain of obtaining these tools, at all times, of the best material and workmanship, and without variation from standard sizes.

The pipe taps are constructed on the same principle as the dies—that of interchangeability—the cutting portions being inserted in longitudinal slots on the body of the tap, so that any one of the slips or cutters may be removed, if injured, and replaced by a duplicate, fitting in its proper and relative place, thus avoiding the rejection of the entire tap, and saving unnecessary expense.

These tools are manufactured under letters patent issued to J. J. Grant, assignor to the Pratt and Whitney Company, Hartford, Conn., and the agents in England are Messrs. Churchill, Finsbury.

Chemistry applied to the Arts, Manufactures, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Acids, Alkalies, and Salts.*

APPARATUS for distilling Sulphuric Acid.—Messrs. FAURE and KEPLER have invented an apparatus for distilling sulphuric acid much more cheaply than hitherto. It consists of a wide shallow platinum basin, covered with a leaden bell having two walls, between which water circulates to keep the bell at a moderate temperature. The edges of the basin being turned down, are joined to the leaden bell with a hydraulic closing, so that the two metals do not come into contact, and the weak acids and lyes are collected in this channel. On one side the basin receives through a leaden pipe the acid at 60° which comes out of the preparatory concentration boiler, and on the other it discharges it without intermission through a platinum pipe.

When the apparatus is intended for producing a large quantity, or more than 8,800 lbs. every twenty-four hours, it consists of two basins, one a little higher than the other, and the concentration is performed by cascade. A considerable reduction is thus obtained in the weight of platinum employed, and these apparatus cost only half as much as those hitherto used. There is consequently an equal reduction in the wear and waste of the precious metal, together with a great facility in producing acid at 66° with the two basins, an increase in the produce of concentrated acid, and, lastly, a saving of combustible materials, which the inventors estimate at about 50 per cent. Though the management of the apparatus is rather delicate, it can be acquired by practice in a little time. *Moniteur Industriel Belge, March* 1, 1876.

§ 2. *Metallurgy.*

A Brown Patina Covering for Zinc.—According to Professor KLETZINSKI, a very diluted solution of molybdic acid, or molybdate of ammoniac in aqua fortis, or a solution of molybdic acid in an excess of soda lye, gives a bath which covers zinc, when plunged into it, with a brown patine having beautiful rainbow reflections. It is probable that a very thin layer of molybdic acid is deposited, which produces the phenomena of iridescence. This layer adheres very firmly to the metal. *Revue Industrielle, Feb.* 16, 1876.

A Mode of Searching for Gold in Alloys.—Begin by isolating the gold from the other metals by changing it to chloride of sodium and gold through the intervention of chloride of sodium or common salt, and concentrate the solution by evaporation. To find the gold, use a solution of sulpho-cyanide of potassium containing one part of salt to 15 or 20 of water. Pour into a test tube about 6 grammes (nearly 4 dwt.) of this solution, and a few drops of the solution of the double chloride. If this last contains gold, a red cloud will be immediately formed, which will soon give a precipitate. This re-action brings to light the least traces of gold. *Revue Industrielle, Feb.* 9, 1876.

Plating of Metals.—For plating various metals, *e.g.* iron, steel, brass, lead, and zinc, M. VEGLER recommends the following process:—Prepare a solution of perchloride of tin by passing chlorine through a concentrated solution of salt of tin. Dilute the product by 8 to 10 times its volume of water, and filter, if necessary. The article, half scoured with sulphuric acid, is to be polished with sand and the scratch-brush, then washed with water, and hung by a zinc wire for 10 or 15 minutes in the solution of perchloride of tin. Afterwards take it out, rub it with the scratch-brush, dry it, and polish it. *Revue Industrielle, Feb.* 9, 1876.

Mode of Magnetizing Platinum.—It has for several years been observed that nuggets of platinum, like the best magnets, have the property of attracting iron. M. de Kokscharoff, a well-known Russian traveller, and correspondent of the French Institute, has proved that the force of these platinum magnets is superior to that of the ordinary protoxide of iron magnets which are found in nature. The Duke of Leuchtenberg has a platinum magnet, nearly nine pounds in weight, which has a strong force of attraction.

It was a question whether the magnetic property resided in the platinum or in some allied metals in the ore. This question has been decided by M. Daubrée, Principal of the Mining School at Paris, by producing platiniferous magnetic alloys as powerful as the natural nuggets.

The able Inspector-General of mines has found that the magnetic property of the platinum ore was owing to granules of iron contained in the platinum. By fusing 18 to 20 parts of iron with about 80 of platinum, a platinum magnet may be obtained. If more or less iron were added, the magnetic property would be much diminished. It is necessary to observe the above proportions exactly.

This result, which reveals to us the secret of the platinum magnet, may have some practical importance. Steel rusts, and the magnetized needles of mariners' compasses are soon corroded at sea; while platinum is proof against the attack of rust and cannot be oxidized. Platinum needles may, therefore, be employed with advantage instead of steel needles. *Technologiste, Feb.* 19, 1876.

Test of Pyrites containing Gold.—It is no uncommon thing to meet with pyrites containing gold, especially in Austria. The following process will serve as a useful test. Roast a specimen of it, weighing about a kilogramme (2·2 lbs.), then put it into an iron mortar, and with the pestle and some water make a thick paste of it, to which add a spoonful of mercury. Bruise again with the pestle, and after a little time add an equal quantity of mercury, then bruise again, and pour in hot water, soda, and six spoonfuls of mercury. Continue bruising again for some time, and lastly wash the pasty substance in glazed capsules. Collect the amalgam and distil it. In this way may be obtained 80 to 90 per cent. of the gold that testing by the dry method would give. *Hüttenmännische Zeitschrift*, 1875.

The Quality of Steel Discovered by Magnetising.—The growing importance of steel in manufacture within the last few years has naturally led to researches and experiments upon it. Among others may be mentioned those of Messrs. TRÈVE and DURASSIER, which, though specially directed to steel used for artillery, have equal value for industrial arts in general. They relate to the distribution of magnetism in the interior of magnets, and the result was to show that magnetism penetrates the whole mass of a steel bar with a section of 16 millimetres (·62 in.). Subsequent investigation also showed that there is a relation between magnetism and the temper of the steel. Consequently magnetism would reveal the physical constitution of the metal, its more or less homogeneity, and therefore its greater or less degree of resistance. These facts are of great importance, and their practical value is evident. *Technologiste, Jan.* 22, 1876.

Nickel.—The Rev. W. B. CLARKE, a geologist in New South Wales, lately read a paper at the opening of a scientific society, in which he ascribed the first discovery of nickel to a French engineer, M. Garnier. The great rise in the price of nickel during the last few years has attracted the attention of manufacturers. Numerous demands for concession at different places in New Caledonia, confirm what M. Garnier wrote in 1869.

"Serpentine rocks, and in general all rocks accompanying them, are often covered with a beautiful green coating, which is nothing else than a silicate of alumina, nickel, and magnesia. Nickel in this state is so abundant among the serpentine rocks of New Caledonia, that it is to be expected a bed fit for working may one day be found. This metal, which is worth 12 francs (9*s.* 8*d.*) a kilogramme (2·2 lbs.), is used in Belgium for making small coin."

At the present day the price of nickel is 40 francs (£1 12*s.*) per kilogramme, and this beautiful metal, which in appearance and qualities approaches silver, is more and more sought after. Hitherto it has been extracted after numerous operations from the speiss or amalgams in which nickel is mixed with many foreign substances, such as sulphur, arsenic, cobalt, antimony, &c. With the ore of New Caledonia the extraction of the metal will be simpler, and the product purer, that is to say, superior; in fact, the metal is here combined only with earthy substances.

Nickel is found in the serpentine rocks so abundant in various parts of New Caledonia, either in irregular masses, or in threads sometimes enlarging to real lodes in connection with copper. This new ore, of a peculiar green colour, might be confounded with carbonate of copper, and perhaps the miner, deceived by the resemblance, may already have met with it in the serpentine rocks of other countries, and taken it for a poor copper ore not worth further examination. Be this as it may, 500 tons of nickel ore have been despatched for France from the mines of New Caledonia, and it seems probable that a regular supply will be maintained. It is also likely that, when the price gets fixed, it will approach that of silver, for which nickel may be substituted in many cases. *Les Mondes, Feb.* 10, 1876.

Process for Hardening Zinc.—Messrs. BOIGNOL, FARJON, and DELPIERRE harden zinc by pouring into the metal, while in a state of fusion, a proportion of sal ammoniac varying from 3½ to 7 oz. per kilogramme (2·2 lbs.), according to the degree of hardness desired. Metal thus prepared can be worked with the file and the turning lathe, and may with advantage serve as a substitute for bronze in many cases. *Moniteur Industriel Belge, Feb.* 20, 1876.

A Good Process for Tinning Iron.—Herr HASS recommends the following method of tinning wrought or cast iron. After the iron article has been filed, polished, and turned, clean it dry, and, while employing an electric current, dip it in a bath consisting of 3½ oz. of solution of tin 40° Beaumé, 35 oz. of spring water, and 7 oz. of caustic potash lye 33° Beaumé. In this bath the iron article must remain till sufficient tin has settled upon it. The tin is deposited of a dull grey colour, but receives a bright polish on being rubbed with a cloth. It is polished at any time with whitening and wash leather. *Bayerisches Industrie-und Gewerbe-Blatt. Dec.* 1875.

The Influence of Various Solutions on Iron-rust.—Herr WAGNER has undertaken a series of experiments to determine the influence exerted on the formation of rust by the presence of various substances employed to prevent incrustation, particularly soda, lime, chloride of borium, &c.

He has ascertained that substances having an alkaline reaction, such as lime and soda, completely prevent the oxidation of iron under water. On the contrary, the chlorides (of magnesium, sodium, barium, calcium, &c.) rapidly attack iron, whether cold or boiling hot, as soon as the air has access.

It may be questioned, therefore, whether the use of chloride of borium as a preventive of incrustation is really beneficial, and whether the advantages resulting from the elimination of gypsum are not nullified by the injurious action of the chloride formed. This evil may go to great length if the elimination water is much charged with sulphate of magnesia, on account of the consequent formation of chloride of magnesium. The presence of ammonia is injurious in all cases. The addition of oil, or greasy substances, to the feed-water of boilers cannot be injurious; on the contrary, it lessens the formation of rust. *Dingler's Polytechnisches Journal.*

A Gold-like Alloy.—A gold-like alloy of fine grain, which is malleable, admits of a high polish, and does not rust in the air, may be obtained by fusing together 100 parts of pure copper, 17 of tin, 6 of magnesia, 3·6 of sal-ammoniac, 1·8 of quick-lime, and 9 of tartar. The copper should be melted first, and magnesia, sal-ammoniac, lime, and tartar gradually added in small quantities. After this the tin should be put into the crucible in small quantities, and the whole kept in a fluid state for 35 minutes, after which the mass may be left to cool. *Gewerbehalle.*

The Working of Gold Mines in California.—The working of gold in California has undergone great changes. There was a time when a wooden trough and a certain amount of patience sufficed for obtaining gold. Men went along by the side of streams, washed the auriferous sand in the current, and made a fortune when they did not die of hunger. What gold there was to be got, was thus obtained by thousands of miners at first. It was exported by millions, and large towns were built in the district of the mines, such as San Francisco, Sacramento, &c.

At the present day the trough miners have disappeared. This does not imply that California is exhausted. It has merely given up the gold on its surface, the nuggets being carried away by the rain, the storms, and the torrents. It still contains an enormous supply of gold heaped up in hills of gravel compacted by a blueish, hard, and resisting clay, some 200 ft. high.

This mass contains enormous blocks of auriferous quartz. The most celebrated and richest deposit extends from the county of the Sierra to that of the Placers, crossing the Pacific railway at Gold Run. This deposit, which has received the name of the blue lode, is worked at intervals for a distance of more than fifty miles. Its breadth varies from 1,000 to 3,000 ft., with a depth which sometimes exceeds 300 ft. It is calculated that each cubic foot may yield gold worth 1*s.* 6*d.* to 2*s.* 2*d.* and even 2*s.* 6*d.*, so that the whole deposit may contain millions of pounds sterling in value.

At first mining property was divided into very small portions, which hardly exceeded 100 to 200 square feet. The miners washed away the superficial deposit of gravel as far as possible by means of trenches made to the edge of the nearest ravine. They then abandoned the work, leaving the auriferous deposit almost intact. Knowing speculators afterwards came and purchased these abandoned mines. When they had thus acquired an extent of 120 to 300 acres, they formed companies which did not hesitate to lay out large sums in mining operations. In this way the present system of working the mines came into vogue, which consists in sapping the hill at its base by hydraulic jets of great power.

Water is fetched from a great distance, as far as twelve to eighteen miles. The body of the rock is cut, aqueducts are constructed, tunnels made, and, at whatever cost, water is conveyed to reservoirs situated as high as possible above the face of the cutting, which is acted on by a pipe measuring 3 to 4½ in. in diameter, and discharging a column of water with a pressure of six to ten atmospheres, which nothing can resist. The clay soil is crumbled, and the blocks of quartz, not exceeding 9 cubic feet in size, are rolled along with the gravel. The blocks, which reach the weight of two or three tons, stop on the way, and are removed from the channel by a crane worked separately.

The muddy torrent goes into the labyrinths where the deposit takes place. They are generally erected in a subterranean gallery, into which the water pours down through a well, towards the mouth of which the working trenches converge. This tunnel communicates with the nearest ravine, into which the water falls after losing its deposit. It is sometimes 550 to 650 yards long. The working thus continues till all the gravel is removed that can flow through the tunnel, after which another tunnel is made, and the same operations are repeated. Thus, instead of the first rude kind of working, an improved system of industrial operations has been established. *Technologiste, March* 4, 1886.

A White un-Oxidising Alloy.—M. MARLIE obtains a white un-oxidising alloy from 10 parts of iron, 35 of nickel, 25 of brass, 20 of tin, and 10 of zinc. Articles made of this alloy are plunged white-hot into a mixture of 6 parts of sulphuric acid, 10 of nitric acid, 5 of muriatic acid, and 28 of water. *Gewerbehalle.*

Discovery of a Tin Mine in Tuscany.—At one of the recent meetings of the Paris Society of Civil Engineers it was announced that a tin mine had been discovered about a mile and a quarter to the south-west of Campiglia Maritima at Cento Camerelle, on the west slope of Fumachio, which is a branch of the Monte Calvi range, already celebrated for the deposits of copper, lead, and iron that it contains.

The ore occurs in a lode about three-quarters of a foot thick, forming a wall between the limonite, or bog iron ore, and limestone that inclose it. This limestone, according to all geologists who have studied the locality, belongs to the lias formation. This point is worthy of notice, because tin has not hitherto been found in secondary formations, and without direct relation with granite.

The lode appears to run nearly from east to west, and is almost vertical. The tin ore is composed of a yellowish grey colour, very dense, with granulous fracture producing a greyish white dust, and strewn with small geododes of carbonate of lime. Its produce of metallic tin varied from 58 to 72 per cent., according to the specimens.

This discovery of tin in the centre of ancient Etruria throws some light on the manufacture of bronze by the Etruscans, who

made frequent use of that alloy. *Moniteur Industriel Belge, March* 10, 1876.

§ 3. *Dyeing, Calico Printing, Bleaching, Tanning, and Allied Subjects.*

New Printing Ink.—Messrs. KERCHER and EBNER have invented a new printing ink with iron base. It is prepared by first dissolving iron in sulphuric, hydro-chloric, or acetic acid. Half the solution is oxidised by means of nitric acid, after which the two halves are mixed, and precipitation is produced by the oxide of iron. The precipitate is filtered, washed, and mixed with equal parts of tannic and gallic acid, which produces a black bordering on blue. The black is washed and dried, then mixed with linseed oil, and an ink is obtained suitable for printing, lithography, and wood or metal engraving.—*Revue Industrielle, Feb.* 9, 1876.

Improved Zinc White.—It appears from the report of the Austrian Chemical Society, that M. ORR has found the following method effectual in producing a very beautiful zinc white. Wash sulphuret of raw barium, and mix it with the liquor obtained from equal equivalents of chlorine and sulphate of zinc. Collect the precipitate (sulphuret of zinc), press and dry it; then heat it on a hearth, and put it quite hot into cold water. This last step gives the mass great density. The product, washed and ground fine, has a coating colour of remarkable purity and whiteness. *Technologiste, Feb.* 5, 1876.

Washing Wool with Lupine Pods.—Herr ROHLACK announces in the Mecklenburg Agricultural Annals, that he has completely succeeded in clearing the wool of his flocks from every greasy substance and all impurity by steeping it for various lengths of time in a liquid which he prepares from bruised lupine pods. He then drains the wool on a sieve, and finishes with washing in pure water. He has thus obtained perfectly clean and soft wool, equal to that washed in the best establishments. This preparation may also serve for cleaning woollen articles or textures without injuring the colours in any degree. *Technologiste, Feb.* 26, 1876.

Galenite.—M. J. DAVID gives this name to a product which is obtained by roasting slowly at a moderate temperature galena, or sulphuret of lead, and is consequently a mixture of sulphuret and oxide of lead. Galenite is likely to replace minium, or red lead, for coating metals, and pure white lead for the first coat of paint in houses. It is very drying, forms a good coating, adheres firmly, and is economical, because it requires only a small quantity of oil. *Technologiste, Feb.* 26, 1876.

Aniline Black Ink.—It is well known that aniline black, properly so called, is nearly insoluble in most chemical re-agents. It is applied to textile fabrics in a pounded state, or developed on the texture or paper by the re-action of a salt of copper on hydrochlorate of aniline. It thus furnishes an intense and indelible black. But a mixture of salt of copper and hydrochlorate of aniline is not long in the air without undergoing great changes. It soon turns to green, and deposits insoluble aniline black. This prevents the use of this black for flowing ink. Latterly, however, it has been found possible to prepare, with aniline and methyl, colouring substances of a blueish black shade, so intense and soluble in water that they can be used in the preparation of beautiful black writing ink.

One of these substances is an article of commerce under the name of soluble nigrosine. It dissolves in water with a slight residuum, and, without thickening, furnishes a beautiful blue black, which is purple in reflected light and immediately becomes intense black on paper. It is, consequently, an ink that does not change, flows easily from the pen, does not turn brown, and, when dry, can be again rendered fluid with a little water. It does not possess the intensity of the black from gall-nut, but a softer and more velvety tone. Although prepared with a soluble salt, it is not obliterated when dry, and not easily when moistened, unless it is too thick. On the other hand, the fibre of the paper does not completely absorb this colouring substance; the residuum continues as a deposit on the surface, and can be removed. This imperfection may be remedied by diluting the black with water. Acids change the characteristics into blue without destroying them, and, on account of the perfectly neutral re-action of nigrosine, this ink does not at all attack steel pens and render them unfit for use. *Technologiste, Feb.* 26, 1876.

Glauber's Salt and its Use in the Dyeing of Wools.—The sulphate of soda ($Na^2 6, SO^3 + H^2 O$) is known in commerce as Glauber's salt, and sold in large white crystals. Its remarkable chemical properties facilitate its use in the dyeing of wools. By its combination with acid the neutral sulphate is transformed into bi-sulphate, and this property is of great value in dyeing.

Ordinary litmus, violet litmus, fuchsine, red dyeing woods, turmeric, the red dyes, madder, logwood, and yellow wood are, it is well known, absorbed in only a very small proportion by woolly filaments in the presence of diluted acid; but if Glauber's salt is added to such a bath, then in consequence of the combination between this salt and the acid, a great part of the acid is precipitated, and all the advantage of the dyeing materials can be reaped.

Consequently the dyer has in his own hands the means of regulating the operation. It will be sufficient for him to add more or less Glauber's salt, but, of course, the quantity of it employed must be proportionate to the quantity of acid in the bath. If, as is sometimes the case, an attempt is made to attain the same object by rendering the bath stronger, or using it for a longer time, the harm done by entangling the fibres of the wool far outweighs the advantage gained by the use of the Glauber's salt.

With soluble indigo Glauber's salt gives an equally good result, but its action is diametrically opposite. It is well known how rapidly and unequally the bath of soluble indigo is exhausted. The rapid precipitation of this colouring substance is easy to understand, since in the presence of the acid the indigo possesses a great affinity for the woolly fibres. Hence one ought not to be surprised, after plunging three skeins into a bath of this nature, to see the third drawn out almost white. If Glauber's salt is added to the bath, it combines with part of the acid, and the operation of dyeing is rendered more uniform, while its duration is prolonged.

The following receipts for dyeing baths have been found useful:—

Bluish green for three pieces of cloth.

Alum	5·040 kilogrammes.
Crystal	·420 „
Soluble indigo or carmine	·175 „
Glauber's salt	1·680 „
Flavin (Flawin)	·0175 „

Billiard-table green for three pieces of cloth.

Alum	8·400 kilogrammes.
Glauber's salt	5·040 „
Carmine	1·680 „
Picric acid	·350 „

Heat to 167° F. for an hour and a half.

Logwood blue for four pieces of cloth.

Alum	4·480 kilogrammes.
Chromate of potass	1·120 „
Blue vitriol	·560 „
Tartar	2·240 „
Glauber's salt	6·720 „
Sulphuric acid	2·240 „

Boil for an hour and a half, and add 22·400 kilogrammes of logwood. *H. Söderstrom in Deutsche Wollen Gewerbe.*

§ 4. *Food, Water, and Sanitary Matters.*

The Effect of Cold on Milk.—It has been ascertained that if milk, directly it comes from the cow, is subjected to a temperature varying from freezing point to 96° Fah., and kept constantly at that temperature for twenty-four or thirty-six hours, the following results are obtained:—1. The cream rises more rapidly in proportion as the temperature approaches freezing point; 2. the quantity of cream and the produce of butter are greater when the milk has been subjected to a greater degree of cold; 3. the skim milk, butter, and cheese are of better quality. Hence, it is an error to suppose, as many do, that an average temperature of not less than 54° is necessary for the making of butter. *Revue Industrielle, Feb.* 9, 1876.

Curing Meat.—The following is a good method of curing or pickling meat. Boil over a slow fire 2 lbs. of rock salt, half-a-pound of sugar, and a quarter of a pound of saltpetre in a gallon and a quarter of pure water, skim the mass during the boiling, and pour it, when cold, over the meat, which must be completely covered with this liquor. Small pieces of meat will be sufficiently cured in four or five days. Hams, if at all large, require a fortnight. Before the meat is laid in the liquor, or rather is covered over with it, the blood must be squeezed out of it, and the meat well washed and dried.

The same liquor may be used two or three times, if it is boiled again, and a small quantity of the above ingredients is added in the given proportions. This boiling again is necessary when a film is formed, or is beginning to form, over the liquor. Of course liquor that is once bad can never be used again.

Meat thus cured, though it has lain long in pickle, will, on being boiled, make excellent broth, which is not the case with meat cured in the ordinary way. Cooked pork also can be left in this liquor a long time, and its flavour will be thus considerably improved. *Bayerisches Industrie-und Gewerbe-Blatt. Jan.* 1876.

Breweries in the United States.—During the year ending July 1, 1875, the produce of duties on beer in America shows that 8,880,629 casks of this beverage were produced there. The number of breweries at work where brewing is carried on is divided among the states as follows:—In New York 203 breweries, in Pennsylvania 235, in Wisconsin 232, in Ohio 210, in California 202, in Illinois 165, and in Michigan 149. Massachusetts does not produce much beer, but during this last year 609,923 casks were drunk there; that is to say, more than in any other state.

Use of Hydrochloric Acid in obtaining Sea Salt.—Mr. F. BALE has obtained a patent for a process which consists in conveying the gaseous hydrochloric acid which is formed in the preparation of Glauber's salt, not into pure water to condense it, as is usually done, but into the water of salt-works. This acid takes the place of the salt in the solution, and on the one hand is obtained diluted hydrochloric acid, and on the other crystallized sea salt.

Sparkling Wines.—The Rheims Chamber of Commerce lately published a statement of the sales of sparkling wines in the Department of Marne, from April, 1874, to 1875:

	Bottles.
There were sold to foreigners . .	15,318,345
" " to home consumers .	3,517,182
Total	18,835,527

Hence the whole amounted to nearly 19,000,000, which, at 3 francs a bottle, produced 55,000,000 francs (£2,200,000), of which 45,000,000 (£1,800,000) came from abroad.

Besides champagne, other white sparkling wines are growing into importance; hitherto France has enjoyed a monopoly of such wines, but in the south of Switzerland, the United States, and California active efforts are made to compete with France in this branch of industry, and though at present they have not met with great success, enterprise and perseverance may yet be effectual to some extent. *Les Mondes, March* 2, 1876.

Domestic Ice-houses.—The following is an economical method of making small ice-houses indoors:—Dig a hole in a cool cellar, and make it of a size corresponding to the quantity of ice to be kept. At the bottom of this hole dig another of smaller diameter, the edge of which goes down with a gentle slope. This kind of small pit, the depth of which should be greater in proportion as the soil is less absorbent, must be filled with pebbles and sand. The whole circumference of the large hole is to be fitted up with planks, kept up along the sides with hoops, to prevent the earth from falling in. Then the bottom and all the circumference of this sort of reservoir must be lined with rye-straw, placed upright with the ear downwards, and kept up along the planks by a sufficient number of wooden hoops. The ice is then to be heaped up in this ice-house, which must be covered over with a great quantity of hay and packing cloth, on which should be placed a wooden cover and some light straw.

Ice may also be preserved very well by pressing it into square or oblong moulds, and leaving it in a cool place, taking care to cover it with straw and sawdust. *Les Mondes, March* 2, 1876.

The Antiseptic Properties of Borax.—MR. ROWBOTTOM of Birmingham, in a visit to Sierra Nevada and California, with a view to discover raw materials for manufacture and commerce, met with a deposit of borate of soda, accompanied by borate of lime and sulphate of soda, in South California. The earth containing borax is conveyed by Chinese workmen to iron boilers, where it is boiled in water for six hours. The concentrated solution is poured into iron vessels, the sides of which are soon covered with a crystalline crust three inches thick. The substance thus obtained is despatched to San Francisco, and thence to Liverpool. It contains out of 100 parts, 99·75 of borate of soda, and ·25 of impurities. It is used without being refined, in various manufactures, among others, in that of porcelain. To give it a better appearance, it is made to crystallize a second time. The deposit is capable of furnishing millions of tons.

Mr. Rowbottom mentions a striking proof of the antiseptic properties of borax. He met with the carcase of a horse lying in a layer of borax earth. The animal had been there about four months. In spite of the great heat, which there reaches 115° Fah., the horse was perfectly free from bad smell, its flesh was quite fresh, the pupil of the eye clear and bright, the hair supple, and firmly attached to the skin.

At the dairy at Lodi, in Italy, four series of experiments were made on the use of salicylic acid: 1, in the preservation of milk; 2, in the separation of the cream; 3, in the preservation of butter; and 4, in the preparation of cheese by ordinary pressure. The conclusion arrived at was, that salicylic acid is not likely to be much used in the dairy, except for the preservation of butter, especially as borax, which is cheaper and easier to use, affords the same advantages as salicylic acid. *Comptes Rendus, Tome* 82. *No.* 9.

The Preservation of Eggs.—It is said eggs may be preserved perfectly fresh for six months by lightly covering them with linseed oil, and placing them on a layer of sand about half an inch deep, so that the separate grains do not touch. The oil may be put on with a painting-brush, a sponge, or the finger. *Praktischen Landwirth.*

Guano Deposits in the Bahama Islands.—It appears from a report of the Governor of the Bahama Islands, that they contain extensive deposits of "cave earth," or guano, which may well vie with the Peruvian in quality, quantity, and accessibility. He calculates the quantity at 400,000 tons, and the excellence of its quality is pretty plainly shown by the fact that the material is now selling in the American markets at from £7 to £12 per ton, which latter price is that of the finest Peruvian. There is an annual export of 30,000 tons, on which the Governor proposes to lay a duty of 2*s.* a ton. This would produce an income of £3,000 a year. Unfortunately, by some oversight a monopoly of the article has been granted to some Americans for seven years at a yearly rental of £100 and a royalty of 2*s.* a ton. It is easy to see that the gains of these American speculators must be enormous at present prices. There is some faint hope that by the end of their seven years they may not have obtained and removed more than half of the whole deposit in the islands.

§ 5. *Fuel, Heating, Illumination, &c.*

Production of Coal in the United States in 1875.—Although it is not yet possible to give the exact figures as to the production of coal in the United States during the past year, it may be safely stated that on the whole there was an increase upon the preceding year, in spite of the unprecedented depression in every branch of industry. In 1874 the production was as follows:—

	Tons.
Anthracite	21,679,886
Bituminous coals	22,543,468
Lignite	1,086,626
	45,309,980

In 1875 the production of anthracite varied little, notwithstanding the increase of extraction in the district of Wyoming, but Leigh and Schuylkill have suffered grievously from a strike of six months. There appears no reason to doubt that the mines are capable of producing half as much again as they do now, and that they will do so, if the present high prices continue.

The importation of foreign coal has been greatly diminished, owing to the cheapness of good native coal. English coal is now used simply for domestic purposes in certain towns, and by some gas companies. On the coast of the Pacific the importation of Australian coal has greatly increased.

Coal Production in England and France.—According to M. LEVASSEUR, the annual production of coal since the commencement of this century has risen as follows:—

Years.	England.	France.
1800 . . .	10,000,000 . . .	850,000
1825 . . .	15,000,000 . . .	1,500,000
1850 . . .	60,000,000 . . .	4,500,000
1875 . . .	132,500,000 . . .	17,000,000

The English miner produces 313 tons a-year, the French miner 169, and this difference is owing to the fact that the French workings are at much greater depths than in England. In France, from 1868 to 1872 inclusive, the miners worked on an average 281 days a year, while in England they worked only 260 days. *Revue Industrielle, March* 1, 1876.

Gas Pits in Pennsylvania.—Mr. LAWRENCE SMITH furnishes the following particulars to the French Société d'Encouragement with regard to the gas pits in the east of Pennsylvania:—

The most abundant gas pits are those known under the names

of the Burns and the Dalamater pits. Less than half-a-mile from each other, they are situated in the county of Butler, about 15 miles from the Hardy pit in the same county, the gas of which is conveyed to Pittsburg. These two pits are about 30 miles from Pittsburg in a direct line. Their depth is about 1,600 ft., for they have been dug to the fourth stratum of sand, so well known, at least by name, to all those interested in petroleum.

Delamater pit, at first dug to the third stratum of sand, was a petroleum well of 352 gallons. On being afterwards dug to the fourth stratum, it gave out a gas the pressure of which was such that plummets of 1,760 lbs. weight could be drawn up by the hand. Each of these pits has a diameter of $5\frac{1}{2}$ in.

The gas is almost entirely composed of hydro-carburet ($C^5 H^2$) mixed with a small quantity of oxide of carbon and carbonic acid. Its lighting power is that of $7\frac{1}{2}$ wax tapers, that of coal gas being nearly equal to 16. Its heating power is about 25 per cent. greater than that of bituminous coal. The quantity of gas supplied is about 1,000,000 cubic feet per hour.

Pits have supplied gas for twelve years without any apparent diminution. One at Fairview is said to have fed more than 100 engines with combustible for five years, and its production to be still the same as the first day.

A number of other statements partake so largely of the marvellous that we refrain from reproducing them.

New Submarine Lamp tested at Kingstown.—Experiments have been made at Kingstown on board H. M. ship Goshawk, for the purpose of testing a submarine lighting apparatus submitted to the Lords of the Admiralty by Messrs. Siebe and Gormann, in order to light the operations for the recovery of the Vanguard. Six men went down under water, and remained there with the lamp for an hour and forty minutes. They went to a considerable distance from the source of light and yet were able to distinguish many objects at the bottom of the sea very well.

§ 6. *Miscellaneous.*

The Manufacture of Dynamite.—M. SOBRERO, the eminent Italian chemist, who discovered nitro-glycerine, recently communicated to the Turin Academy some remarks on certain modifications desirable to be introduced into the manufacture of dynamite. According to him, there are in this manufacture two very dangerous operations, which are probably the cause of explosions in the factories where it is carried on. One is the mixture of nitro-glycerine with the flinty material which is its excipient, and the other the compression of the paste in moulds for making the cartridges. In these two operations the nitro-glycerine is liable to friction and pressure, which have a tendency to make it explode. According to M. Sobrero, a safer plan may be adopted than has hitherto been followed, which is this:—first, moisten the flinty material with water and make a paste of it; then, by moulding, give it the form of a cartridge or whatever may be desired. After the moulding, dry the cartridges, so as to get rid entirely of the water. Then plunge them in the nitro-glycerine till they are thoroughly penetrated with it by absorption, which is facilitated by the vacuum created in the receiver containing the moulds plunged in the nitro-glycerine. On the admission of air, the penetration is completed. M. Sobrero has made experiments with an absorbent flinty material of Italian origin, which is well adapted for moulding and capable of absorbing such a quantity of nitro-glycerine that the cartouches contain 75 per cent. of their weight of it. *Revue Industrielle, Feb.* 16, 1876.

A new Log for Ships.—M. Marey has devised an apparatus for giving at any instant the velocity of the motion of a ship relatively to the surrounding fluid. It consists of two tubes bent at an angle, placed back to back, and open at both ends. The current of water, entering into the orifice of one of the tubes, causes in it a rising of the liquid above the external level, and a lowering of the level in the other. The difference of level in the two tubes enables one to estimate the velocity of the current, or, if the water is still, the velocity of the motion of the apparatus; it is a simple result of the theory of relative motions.

To avoid the effects of oscillation and rolling, M. Marey makes these tubes communicate with two aneroid chests, back to back, fastened to a frame at their exterior surfaces, and capable of being completely filled with water, so that the effects of the variation of the level of the surrounding fluid, which are the same for the two tubes, are neutralized. As to the influence of the current, that is rendered perceptible on the movable surfaces of the two chests; the one swells, the other sinks; and from this results a movement of a rod fixed to the two flexible surfaces. This movement is transmitted by a toothed wheel to a needle, which is placed on a dial. The instrument may be graduated by communicating to it certain velocities in still water. Experience shows that it has great sensibility. *Revue Industrielle, Feb.* 16, 1876.

Cable Towing.—Steam towing has within the last few years been developed and extended in Europe. This system of traction is not entirely free from objection, and the use of a heavy chain is certainly a disadvantage. M. de Mesnil has conceived the happy idea of substituting a metallic cable for the chain, and the alteration has been attended with the best results.

On the Oder, between Breslau, the capital of Prussian Silesia, and the Baltic, over a distance of 308 miles, instead of the heavy sunken chain weighing 30 lbs. a yard, a metallic cable at once flexible and light—the weight of which is less than 4 lbs. a yard—is now used. Instead of the heavy steamers, which the continual friction and shocks of the chain soon put out of order, light but powerful vessels are employed, which are free from the friction of the cable during the passage, and the moving power of which is turned to account in the directest manner possible. The advantages of the new arrangement are:—1, a reduction of 45 per cent. in combustible; 2, a diminution of 40 per cent. in the wear and renewal of material; 3, a saving of 30 per cent. in the expense of original manufacture and fitting up. *Revue Industrielle, Feb.* 2, 1876.

A Remarkable Fish.—On the borders of the Lake of Tiberias, at Aid-Tin, the ancient Capernaum, there are numerous hot springs, the union of which forms rather a considerable stream. In these waters, which have a temperature of 75° F., lives a fish of moderate size, of an olive green colour, striped with blue on the back, and having on the belly a silvery brightness with bluish spots. It is called *chromis paterfamilias*, and well deserves to be designated as the father of a family.

When the female has deposited her eggs in a sandy hollow or among tufts of rushes, the male approaches and snaps them into his mouth, but does not swallow them. He passes them among the branchings of his gills. There the eggs undergo all their metamorphoses. The young are hatched and grow rapidly, till at last they get rather crowded. There are sometimes 200 of them. *Les Mondes, Feb.* 10, 1876.

Production of Paper in the World.—The total population of the globe being reckoned at 1,300,000,000 inhabitants, it is estimated that of this number 370,000,000 do not know the use of paper or writing, 500,000,000 of the Mongolian race use a paper made of stalks and leaves of certain plants, 10,000,000 use wooden tablets, 130,000,000—including Persians, Indians, Armenians, and Syrians—use paper made of cotton, while the remaining 300,000,000 use paper such as is manufactured in Europe. The total annual consumption of this latter is estimated at more than 1,760,000,000 lbs., or an average of about 6 lbs. a head. In the manufacture 198,000,000 lbs. of woollen refuse are used, and 796,400,000 lbs. of cotton, without reckoning cloth, straw, wood, &c. Paper is manufactured at 3,800 mills, the number of hands is 90,000 men and 180,000 women. The product is distributed as follows:—299,200,000 lbs. of letter paper, 897,600,000 lbs. of printing paper, 398,200,000 lbs. of paper for hanging, and 199,000,000 lbs. of paste-board and various papers. The manufacture of useful articles out of papier-maché, &c., is likely to develope this branch of industry still further. *Revue Industrielle, March* 1, 1876.

Production and Manufacture of Cotton.—The United States annually produce 3,900,000 bales of cotton, of which 2,400,000 are exported to Europe; India produces 1,800,000, in addition to those employed in native manufacture; Egypt, 47,000, and all other countries together 11,025,000, of which 256,000 come from Brazil. The total production from the whole surface of the globe amounts to 6,575,000 bales, weighing 1,314,900 tons. It is calculated that about a million and a-half workpeople are employed in the manufacture of it. The spinning is distributed as follows:—England has 35,000,000 spindles; North America, 8,000,000; France, 5,700,000; Germany, 4,700,000; Russia, 1,700,000; Spain, 1,400,000; Belgium, 600,000; and Italy, 500,000—making a total of 55,900,000. *La Gaceta Industrial, Feb.* 25, 1876.

Colouring of Paper-pulp Red or Rose-Colour.—In the colouring of paper-pulp it is difficult to obtain a dark tint or one of bold tone, like red and rose-colour. The following is a method of obtaining a beautiful pure red or rose-colour:—

When a decoction is made, much charged with Pernambuco, Brazil, or other red wood, it ought not to be stirred in the refining basin at the same time that the glueing takes place. A quantity of the decoction of red wood, proportioned to the shade desired, is poured into the basin. On the other hand, there is poured on to the resinous soap chloride of tin, which has the property of forming a precipitate of colophony or resin, and

which is afterwards poured into the basin, care being taken to stir as much as possible while it is being poured, until the pulp has taken the required tone of colour. The pulp may then be transferred to the tubs of the paper-making machine. The chloride of tin should be diluted in ten times its weight of water before being mixed with the resinous soap. The shade of red or rose-colour varies with the quantity of tin that is employed, and this chloride is obtained by mixing ten parts of nitric acid with twenty of hydrochloric acid, in which all the tin is to be absorbed until the mixture is dissolved. The tin should be brought to thin flakes before being employed, for which purpose it is fused and poured into cold water. About 9 lbs. of tin are required for the above quantities of acids. In this process it is not necessary to use alum or sulphate of alumina. *Le Teinturier Practique.*

Manometers for High Pressures.—All the manometers for high pressures which have been hitherto constructed, have not given indications of pressure with permanent exactness, on account of the flexibility and elasticity of the metals. M. THOMASET, a mechanical engineer, appears to have solved the problem.

His apparatus, the exact indications of which can be easily understood, is sensitive and unalterable. It is composed of a plate provided with an axis placed in the centre of a vessel of mercury, the superficial area of the plate being in proportion to that of the axis. This vessel communicates by means of a vertical tube with the open air, and a graduated scale—placed along the tube and an india-rubber partition—separates the liquid which fills the vessel from the plate, transmitting at the same time the pressure from one to the other.

It is easy to understand that if the pressure to be measured is transmitted by means of a tube and piston to the central axis of the plate, this will transmit it to the surface of the liquid, part of which will be forced into the tube to a height proportioned to the pressure. The combined forces transmitted by the axis and the plate being equal, it follows that the pressures per superficial unit are in inverse proportion to the superficial areas; consequently the height of the mercury in the tube relatively to the normal atmospheric pressure (29½ in.) will be in the inverse ratio of the superficial areas for every atmospheric variation.

These indications show that by varying the proportion the manometer may be made capable of indicating the highest atmospheric pressures with a limited height of mercury, and smaller variations of tension with greater exactness, by means of which is obtained, not a comparative measurement, but a mathematical graduation dependent on a number perfectly known, and the relation between two surfaces easy to measure with perfect exactness. *El Porvenir de la Industria, Jan.* 21, 1876.

Cast-iron Paving.—For some years past certain streets in Warsaw have had cast-iron paving, the use of which is likely to spread, as experience shows it is very economical. The length of the pieces of cast-iron is about 3½ ft., the breadth nearly 2 ft., and the thickness 3 in.; they weigh on the average 220 lbs. each.

The ground is prepared for paving by spreading over it a uniform layer of broken stones, which are then rammed down and covered over with a light layer of sand to make the surface perfectly level. The cast-iron blocks are then laid down as closely together as possible, and the joints are filled up with sand. The edges have ordinary paving stones. For the junctions of roads blocks of special forms are used, varying according to the curvature.

To keep the paving in repair, broken stones are spread over it now and then, especially where hollows appear. Wet weather is most suitable for this, as it saves the expense of watering.

The following are the chief advantages of cast-iron paving:—speedy repair, constant roughness in summer as well as in winter, unchangeableness of outline even with the conveyance of heavy loads, very easy thawing, and cheap maintenance. The net cost is about £1 3*s.* 6*d.* per square yard; it varies very slightly according to the price of the pebbles and sand.

Cast-iron paving is particularly good for the entrances of yards, because it avoids the production of ruts. *Revue Industrielle, March* 1, 1876.

Mastic for fastening India-rubber on Metals.—A mastic for fastening india-rubber on metals may be obtained by steeping gum-lac, in the form of pulverized scales, in ten times its weight of concentrated ammonia. A transparent mass is thus formed, which, at the end of three or four weeks, becomes fluid without the use of warm water. This substance, applied on india-rubber, becomes hard, and completely impervious to liquids and gases. *Moniteur Industriel Belge, Feb.* 20, 1876.

The Russian Imperial Marine.—Russia possesses 29 iron-clad frigates and 198 vessels of ordinary construction, carrying altogether 527 guns. The tonnage of all these vessels is 173,917, and the horse-power 32,728. *Moniteur Industriel Belge, Feb.* 20, 1876.

Electric Clock-Work.—M. de LAQUERENNE has invented an apparatus for producing a perfect agreement between different clocks, and setting up a public clock at little expense. It consists: 1, of an ordinary chronometer; 2, of independent wheelwork mechanism; and 3, of striking mechanism. Each of these three apparatus is moved by a special motor, and may be put in the place most suitable for its operations. They are connected together only by the electricity which conveys to the two latter the order to act in conformity with the indications of the chronometer, which may be put in a special room very far away from the other two mechanisms. These indications, which it sends by electricity, are mere orders, without any moving power to execute them, this power being supplied by the special motors attached to each of the apparatus. Only, as the striking apparatus must always be in accordance with the dial, the electricity conveys the indication of the chronometer to the wheelwork, which transmits it to the striking apparatus. It might carry it directly to the striking apparatus, if it were not desirable to have a visible dial set up.

To ensure the regularity and certainty of every movement, M. de Laquerenne has recourse to very ingenious contrivances. He thinks the high price of the electric clock is the only reason why it is so little used, and, if this obstacle were removed, its use would be widely developed. It is to be hoped his contrivance will be the commencement of such an advance. *Les Mondes, March* 9, 1876.

Copying Pencil.—For some time past copying pencils have been manufactured, which make marks on paper capable of being copied, like those made with copying ink. These pencils are manufactured thus:—A thick paste is made with graphite, porcelain finely pulverised, and a concentrated solution of aniline violet blue soluble in water. The paste is then moulded and pressed to the form of cylinders about 4 in. long, and an eighth to a sixth of an inch in diameter. After being dried, the pencils are fit for use. Instead of porcelain, gum arabic might no doubt be used with advantage. *Les Mondes, March* 2, 1876.

A Method of Waterproofing Woollen Materials.—The following method of rendering woollen textures waterproof is recommended:—Boil 125 grammes (about 4½ oz.) of white soap in 12 litres (about 2¾ gallons) of water, and separately dissolve 165 grammes (about 5¾ oz.) of alum in 12 litres (about 2¾ gallons) of water. Heat these two solutions to 190° Fah.; then pass the woollen fabric once through the soap bath, and afterwards through the alum solution. Lastly, dry it in the open air. *Muster-Zeitung für Farberei*, &c.

New Blinkers for Horses.—Herr KLOSAK has obtained an Austrian patent for a new contrivance by which horses that have taken fright and run away may have their eyes covered immediately, and so be safely stopped. A tin plate is sewed into the blinkers, and connected with the head harness by a hinge joint, and can be pressed inwards by a spring, so that the blinkers completely cover the horse's eyes. The blinkers are kept in their proper position by a bolt, which is also acted on by a spring. To the bolt is fastened a rein or line, the end of which is in the driver's hands. If the horse shies, the driver pulls back the bolt by this rein or line, and, in consequence of the pressure of the spring, the blinkers turn inwards and completely cover the horse's eyes, so that he is at once stopped. The form and appearance of these blinkers are exactly the same as those of ordinary ones, and, as they are not expensive, their general use as a means of preventing serious accidents may be recommended. *Wochenschrift des Nieder-österrerichischen Gewerbe-Vereins.*

Geodetical Enterprize in Brazil.—The government of Don Pedro II., Emperor of Brazil, has recently appointed a Commission for carrying out geodetical operations having an important bearing on our knowledge of the true figure of the earth.

The first business of this Commission will be to determine the exact position of a series of geodetical stations between the Observatory of Rio Janeiro and the town of San Juan de Rio Claro, the starting point of the projected extension of the line of railway to the mouth of the river Tiele, in Panama. Another result of this operation will be the exact measurement of an arc of a parallel situated in about 23° south latitude, and of 9 or 10° in extent of longitude, connecting the capital of the empire with the great meridian of Brazil.

This meridian, which is in 10° west longitude with regard to the Rio Observatory, passes through the whole of Brazil from

2° north latitude on the frontier of French Guiana, to about 33½° south latitude, where it terminates at the mouth of the river Chuy, the boundary of the state of Uruguay, thus including an arc of more than 35½°, and it would reach 38° if the measurement were extended, as is desirable, to the coast line of French Guiana. The measurement of an arc beginning from the equator and exceeding in magnitude any arc yet measured, is the chief business to be accomplished.

The superintendents of telegraphic lines both on land and at sea will render their assistance for these operations, and when telegraphic stations are not available, use will be made of light signals for the determination of longitudes. These signals will be transmitted by means of registering chronometer apparatus carefully compared with hourly observations made at the Rio Observatory. For the determination of the latitudes of the different stations in this immense geodetical system, recourse will be had to zenith observations, for which an improved telescope of the Rio Observatory will be employed. *Comptes Rendus, tome* 82. *No.* 10.

A New and Improved Gum-Lac.—The gum-lac in general use for industrial purposes does not always give satisfactory results, because it often contains foreign resins and wax, which cause inconvenience. Gum-lac is a resin which exudes from certain Indian trees in consequence of the pricking of the bark by the females of a cochineal abounding in the forests. The branches covered with resin are cut, and the gum-lac is thus obtained.

There are three sorts of gum-lac, one in the form of stick, another in grains, obtained by breaking up the stick, and another in the shape of scales, prepared by melting the two former sorts.

M. Ruinet has succeeded in constituting a new branch of industry for the purpose of giving gum-lac all the purity that is required. The new gum-lac is rather brown, but perfectly pure. It is in thin leaves, like those usual in commerce, and resists fire very well. *Moniteur Industriel Belge, March* 1, 1876.

A New Process for Water-proofing.—Dr. FOURNAISE employs acetate of alumina, obtained from hydrate of alumina and acetic acid, for the purpose of rendering articles water-proof. The textile fabric is placed in a bath marking four to five degrees of the aerometer, and left there for about an hour. It is then passed to the cylindrical press and the stove to be dried and finished. Experiments made at the Palais de l'Industrie in Paris have satisfactorily shown that articles so treated are perfectly water-proof.

The Jury of the Philadelphia Exhibition.—An American journal announces that the jury of the Exhibition at Philadelphia will consist of two hundred members, half of them Americans, chosen by the Centenary Commissioners, and half foreigners. Their business will be to award the prizes, and they will receive 1,000 dollars, in addition to their travelling expenses. Their decisions will be without appeal.

Plating Unglazed Porcelain.—M. HAUSEN, of Stockholm, gives the name of *argentina* to his method of covering unglazed porcelain with a coating of gold, silver, or copper. It is thought the porcelain articles are dipped in a solution of a salt of the metal, and then, by a peculiar process of reduction, the metal is deposited within the pores of the earthenware. Articles covered with a metallic coating according to this process, present every appearance of being entirely composed of the metal. *Deutsche Industrie-Zeitung.*

Soap and its Use in Mechanical Friction.—At a recent sitting the Chemistry Committee of the Industrial Society of Mulhouse, M. BRANDT stated that he had had opportunities of proving the utility of soap for rubbing the axles of a machine and facilitating its rotatory motions. This observation was confirmed by M. Schæffer, who added that resin soap is preferable as grease for machines that require great moving power. M. Rosensthiel thought this effect of soap attributable as much to its lubricating qualities as to its property of preventing the heating of the axles. *Bulletin du Musée de Belgique.*

Bruin's Explosive Powder.—This powder is composed of 60 parts of a mixture of chloride and nitrate of potash, charcoal, and oak sawdust impregnated with 40 parts of nitroglycerine. It is divided into cartridges of 2½ oz.; the explosive effect of this dynamite is extraordinary. Plates of sheet-iron, from ⅛ in. to ¼ in. thick, are torn by 1 or 2 cartridges detonating on their surface. An ashlar wall, 33 ft. long and 23 ft. high, was completely destroyed by 4½ lbs. of dynamite distributed in 6 mining holes, and ignited by an electric spark. *Dingler's Polytechnisches Journal.*

The Use of Gutta Percha for Underground Telegraphs.—No substance has yet been found to take the place of gutta percha for the construction of underground telegraphs.

Hence the object of specialists has been to discover a mode of preserving the insulating properties of this substance. It is well known that these properties require that the gutta percha should be protected from the air, otherwise it becomes hard and brittle through loss of volatile substances. Hence it must be surrounded by a coating which is not affected by air or water.

This is satisfactorily accomplished by means of wooden envelopes impregnated with creasote, which do not rot in the ground, and also keep out the wet. Such is the principle of the telegraph lately invented by Holzmann, which is cheaper than cable, and allows a greater number of wires to be collected together. *Revue Industrielle, March* 8, 1876.

Lifting Effect of Frost on Trees.—Dr. LAPHAM, State Botanist and State Geologist of Wisconsin, says that frost exerts a lifting power on full-grown trees, so as to cause the impression on some that the tree begins to grow again after once attaining its full growth. When the land freezes expansion ensues, drawing the tree up with it, leaving of course a cavity whence the root was drawn. When the first frost comes, the moisture, carrying earthy matter, enters the cavity, and thus the root is prevented from returning to its original position. Dr. LAPHAM suggests that one of the chief offices of the tap roots may be to guard the tree as much as possible against this frost-lifting.

Life-Saving Service Mortars.—Experiments have recently been conducted by CAPT. JAS. H. MERRYMAN, of the United States' Revenue Marine, and MAJOR GEORGE MCKEE, of the Ordnance Corps, U.S.A., with a new North German gun, for firing shot with line attachment over wrecked vessels. This gun is an improvement on the seacoast mortar and line which has been in use here for years, but which has been found of too short range. This German gun is an iron carronade, of about 250 pounds weight, with a two-inch bore, and mounted upon a wooden carriage of strong but light make. The whole is drawn on a waggon of four wheels, the front pair of which can be detached. The gun is supported on the rear pair, and on either side of it are two boxes for the line. On the front axle the leading lines are reeled by which the hawser is hauled. The whole waggon, with its broad-tired wheels, can be drawn over a sandy beach by six men. The gun was placed in position at an elevation of 25 degrees, and was loaded with half-a-pound of powder and a twenty-pound cased iron shot, with a Russian hemp line attached. The shot, describing a curve of about 350 feet high, fell 1,149 feet from the gun, though fired in the face of a 17-mile wind. The line was uninjured. Several trials were made with both German and American lines, and on one of these the line of American manufacture broke in two places. In the last trial, eight ounces of powder sent the shot 1,040 feet from the gun, and without injuring the line. It was demonstrated that the German gun had a greater range than the American mortar in use. *Nautical Gazette.*

Messrs. Fairbank's Scale Works at St. Johnsburg, Vermont, U. S. A. annually consume 3,000,000 ft. of timber, 4,000 tons of pig iron, 3,300 tons of coal, 500 tons of moulding sand, 45 tons of brass, 10 tons of zinc, 360 tons of bar iron, and 50 tons of steel. The motive power is supplied by an engine of 200 horse power, and one or two smaller ones.

CASK MAKING.

THERE are few trades in which jealousy concerning the introduction of machinery prevails among the operatives as in that of the cooper. Accustomed to tradition, and most constant in his toil, there can be no astonishment at his lack of perception of the impossibility of supplying the market by hand-labour; and if he in his ignorance dreads the intrusion of mechanical science, and fails to understand that the introduction of machinery actually augments wages, the world must be kind and patient. But the machine must be allowed to work. His spoke-shave is a machine, and, seeing that that implement cannot supply the demand, we must hail with welcome any inventor who will assist in furnishing what the necessities of trade require, and are sure that the operative cooper will not suffer.

A private view of the works of Messrs. A. Ransome and Co., of Chelsea, supplied a ground of hope that the desired change of manufacture will be effected, and we propose to state in brief the contrivances they have introduced to public observation,

and with which there are being executed large contracts in Spain and elsewhere for the purpose of producing casks for wine-growers and brewers.

In this department of the cooper's labour, oak is the timber employed, and this is of five kinds, viz., Quebec, Virginia, Dantzic, Hamburgh, and English. Old, thick, and straight trees are selected, from which the planks are hewn and formed into staves. In hand-labour the wood is prepared in winter, and the cask put together in the summer. The shaping of the staves with geometrical accuracy, so as to form a double cone, is a slow process demanding skill and practice, besides which the labour is well paid. The forming of staves into segments of a circle narrower inside than out, and thicker in the middle than at the end, by the artificer, is obviously difficult, and deserving a high wage, for the workman has to keep every stave in the proper curve to make his circle.

The impossibility of producing sufficient quantities of casks has led to many mechanical inventions that might accelerate the manufacture, but these were all in piecemeal, and have been neutralized by the persistent opposition of the workmen who took them in detail, and refused to allow of their introduction and employment. The issue of such folly is just this, that now a set of machines have been constructed that dispense with the hand-labour of the skilled cooper altogether, where the demand is sufficiently great to warrant the outlay for machinery, and the artizans will have to shape their policy to a new order of things, or find another occupation.

By the aid of illustrations we propose to lay before the reader the method now prescribed, necessarily omitting several minor machines for lack of space, but all are mentioned in the text.

The first is the Band Saw Machine for sawing out staves from the wood as imported. It is supplied with adjustable guides, which support the saw or saws, and confines them to their proper direction. With it one man, with a boy to receive the sawn staves, will cut from 800 to 900 hogshead staves in nine hours at a speed of 300 revolutions per minute. This is accompanied by a Double Stave Cross-cut Saw for cutting to the proper lengths and squaring both ends simultaneously. A lad can work from it 4,000 staves in nine hours. Attached is a Circular Saw Bench for sawing heading. Heads are made from the crooked staves, or from the centre of trees which is not fit for staves. With this bench one man will cut out the whole of the boards for 300 pairs of heads in nine hours.

Messrs. Ransome's next machine is for Stave Backing. It planes the outer side of the stave, so as to make it conform to the circular shape of the cask when put together, and is a singularly ingenious construction, from the facility it affords for economizing the wood and producing the convexity required. It will turn out about 300 in an hour.

For jointing, these engineers have two machines: the one their own patent, the other that of Messrs. Woolley and Anderson. The latter (fig. 1) is the most economical of any for making tight casks; it joints both edges of five or six hogshead staves in a minute perfectly, and secures at the same time the right "bulge." The cutter spindles are attached to a strong iron frame, hinged at the top, so that the angle of the cutter can be adjusted to any width of stave; these travel by an endless chain fitted with dogs to catch and carry them along at the rate of 25 ft. a minute, cutting the edges so clean and true as to make the cask when hooped perfectly water-tight.

The other machine (fig. 2) is necessary in every large cooperage, because with it the crooked staves that are inevitable in cutting up heavy quantities of timber are cramped, and compelled to take the prescribed shape. One of the chief features of this machine is an arrangement by which the angle of the cutter spindles is varied in one operation to suit different widths of staves, so that the lines of the cutting edges meet at a point representing the centre of a cask of any given size. A lad can joint more than a hundred staves every hour with this machine.

The Stave Hollowing Machine is next in order. It hollows out the inside of the stave, and prepares it for the proper bending. In ordinary work the machine fig. 1 effects this, but in the case of obstinate timber it is necessary to employ it for perfect work.

Two minor machines follow: the one for jointing headings, which shoots the edges and will joint, easily enough, material for 300 pairs of heads in a day. The other is a boring-machine for making the small holes which connect the planks or staves of heading together. By it a boy can bore in one day all the headings for 600 hogsheads.

Fig. 3 represents the Head Planing Machine by which all the heads of casks under 26 in. diameter can, after being dowelled (put together), be rendered perfectly smooth. The head is passed over cutters by a series of toothed rollers keyed to two separate spindles, one before and one after the cutter, and the rollers are so placed as to act on every board in the head, thus preventing the possibility of separation during cutting. This contrivance will plane about 250 full sized heads in an hour.

Then follows in fig. 4 the Head Turning, Ovalling, and Bevelling Machine, by which those three operations are effected at one time, finishing the heads with mathematical accuracy, and delivering them ready for putting into the cask at the rate of more than fifty in an hour. The head is laid with its face downwards upon a circular horizontal table, and is held by a top cramping plate having on its under side steel points that catch every board and prevent the separation of the parts while being cut. The top cramp plate runs loose on its spindle bar; the lower one is keyed to a vertical shaft. The cutters are attached to a horizontal gun-metal block keyed to a steel spindle, and work in a carriage moving on a horizontal slide, which can be moved to suit any diameter of heads. The oval form is given to the head by an eccentric worked by a worm so speeded that the cutter-carriage is made to approach or recede from the head twice in one revolution. This machine is of remarkable ingenuity, and should be seen to be understood.

The Raising or Gathering Machine is next in order, and is of very simple construction. The upper end represents the upper half of a cask having at the top a circular plate corresponding to the head; around this the staves are placed, a truss-hoop is driven over them, and the circular plate is lowered out of the way. When this is finished, it is best to place the work into a Steaming Chamber, to facilitate the bending of the staves. It consists merely of a large cone of wood or sheet iron suspended by a rope, so that it can be raised or lowered. The casks are placed under these cones, and steam admitted under them by a pipe from the steam engine conveying the exhaust steam, which is sufficient for the purpose, and the only time required is that taken up by putting the casks in the chamber and taking them out again.

After leaving the Steaming Chamber, the cask is brought to a new invention called a Close Trussing Machine. One end is laid on a rest fixed to the moving head, and the other is supported by a rest attached to a cast-iron cone, into which the staves are forced by the moving head, and thus are tightly forced together. The cone is bored out accurately, and has recesses turned to take the three truss hoops, which become fixed as tightly as if driven by a hammer. There are several varieties of this machine, according to the number of hoops, size of casks, and kind of goods required.

The last illustration we can give (Fig. 5) is that of what is technically called the Chiming and Crozing Machine, but which means bringing about a correspondence in relation or proportion, or in other words, completing a given mechanical result. At each end of the cask there are the chime and the croze. These are cut by one operation, and at the same time the ends of the staves are bevelled off, thus producing the finish we all know, but with greater accuracy and fineness than hand-work can possibly attain. Its use demands the services of two men, but with that agency it will turn out two hundred casks a day.

To make a steam cooperage complete, there are several little machines or contrivances besides those mentioned. These are first for preparing the hoops for putting on casks, and to this is attached a punching and shearing apparatus; second, a machine for cutting chives out of odd pieces from the ends of staves that are too short for heading; lastly, the great force of all is the steam engine, with whose work and capacity every reader must be familiar.

Now, the practical bearing of all this technical matter is the difference of cost between the hand-labour and a factory of systematically arranged machinery. Messrs. Ransome have a plan for placing all these articles in such order as to avoid wasting labour by having to carry the material from one part to another, which every one who is acquainted with factories knows to be a very serious loss in many establishments. Supposing these plans adopted, and the several stages of manufacture taken in due order, they demonstrate that the total labour on 600 hogsheads made by machinery amounts to £55, or 1*s.* 10*d.* per hogshead, while that at piece-work price paid to a journeyman cooper for a "tonguer" hogshead made by hand is 4*s.* 8½*d.*, which for 600 would cost £141 5*s.* Taking a week's work from the two classes, we therefore find a saving in favour of machinery of £85 5*s.* per week. Of course a large capital is required, but the difference between £55 and £141 is so enormous that the whole scheme must prevail, and be generally employed for all new work in which, if the present coopers refuse to engage, any ordinary workman of common sense will be found equally efficient.

We must express our thanks to Messrs. Ransome and Co. of Stanley Works, Chelsea, for the facilities they have afforded us.

W. S. C.

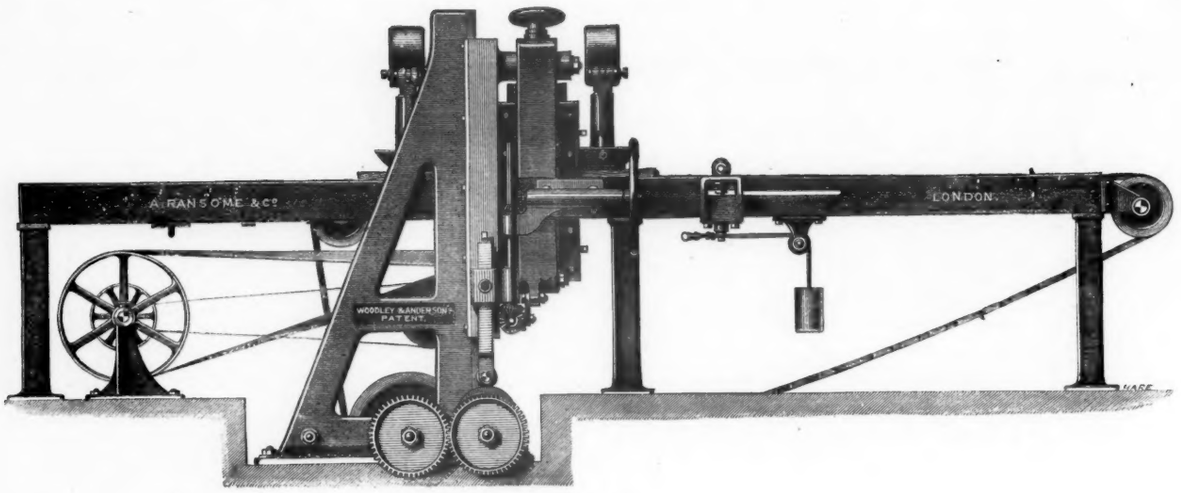

Fig. 1.

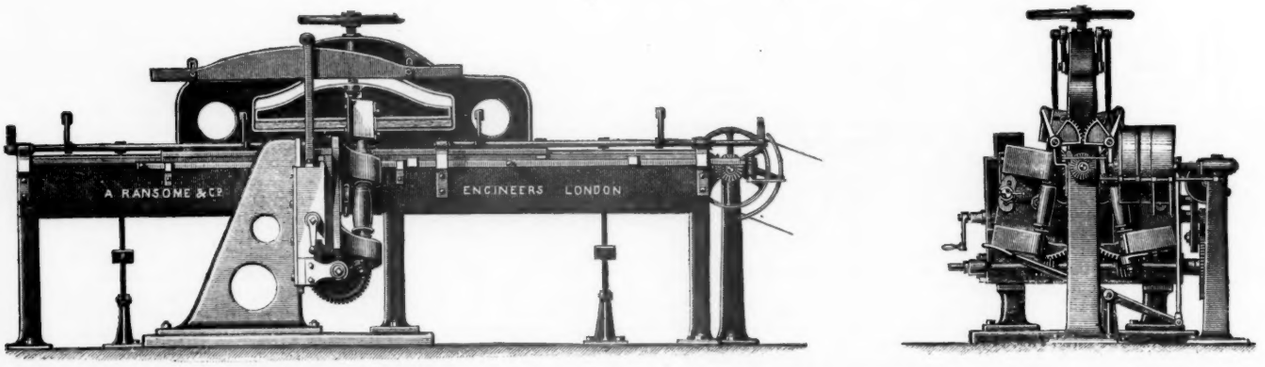

Fig. 2.

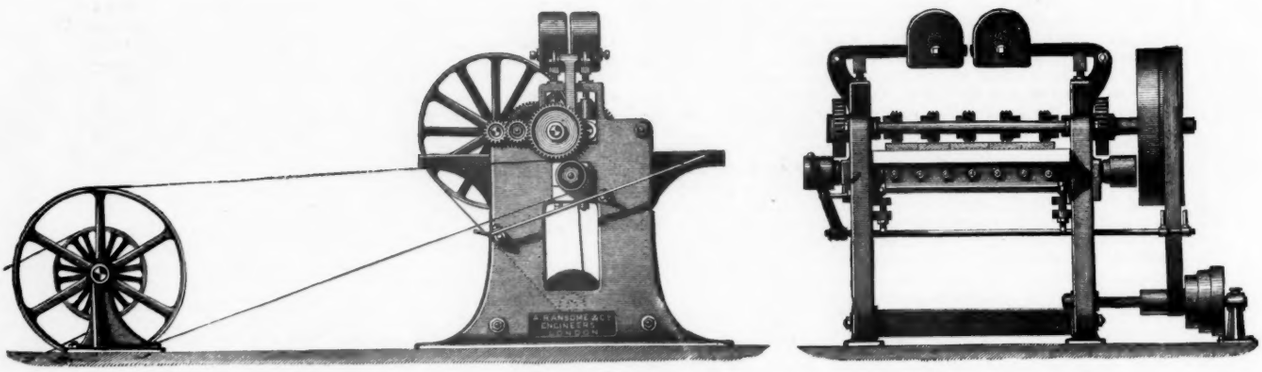

Fig. 3.

RANSOME AND CO.'S CASK-MAKING MACHINERY.

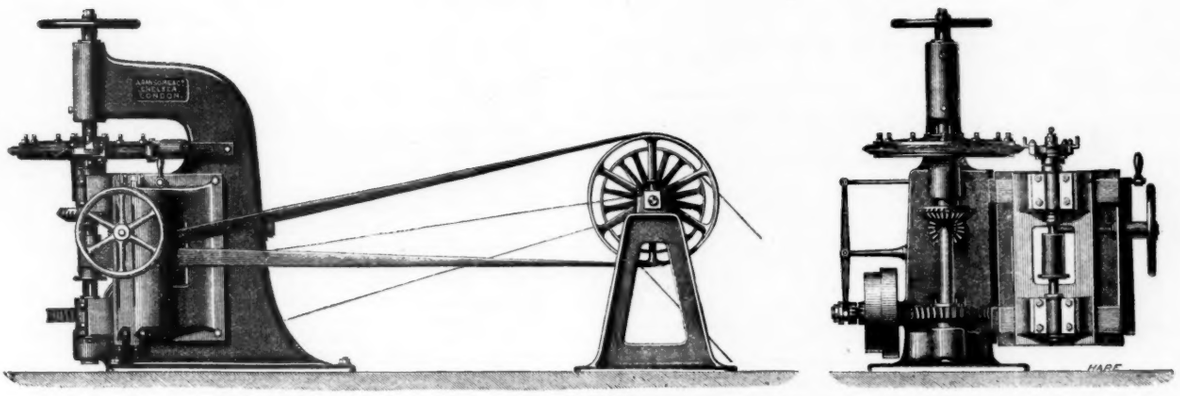

Fig. 4.

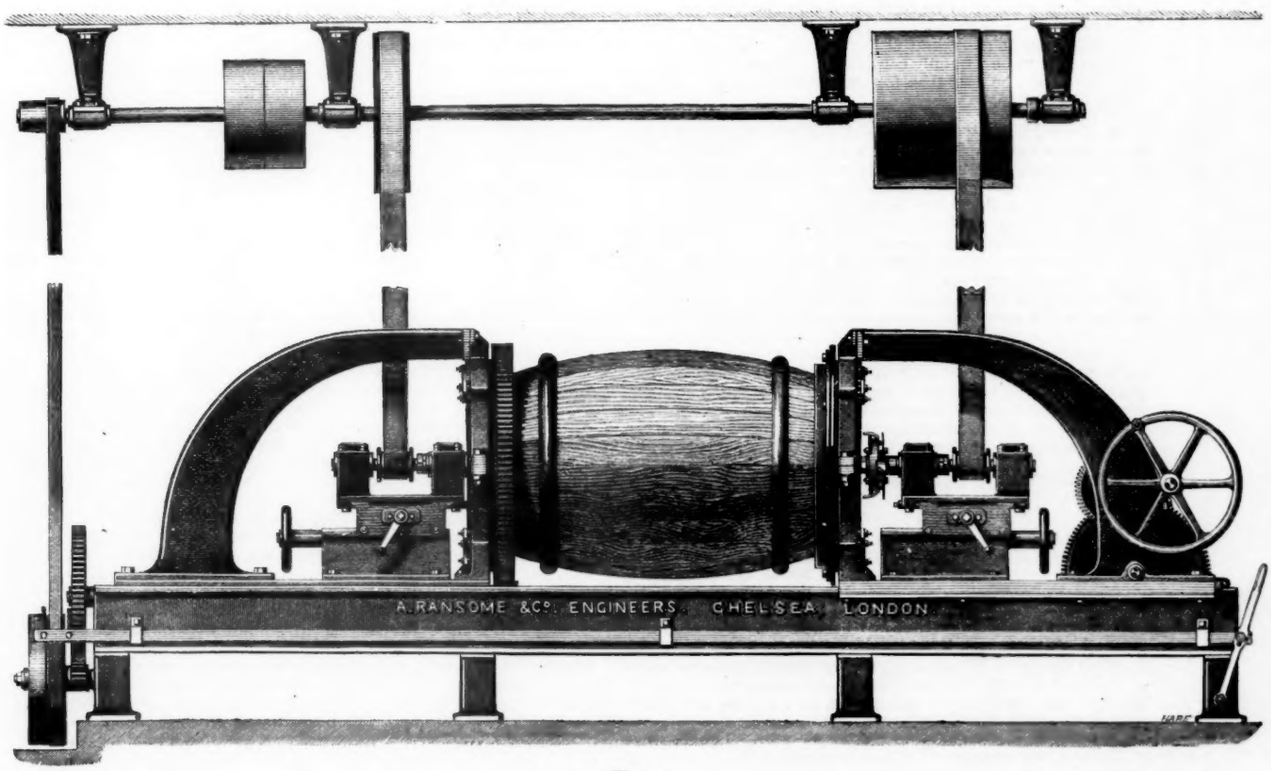

Fig. 5.

RANSOME AND CO.'S CASK-MAKING MACHINERY.

Engineering, Building, &c.

ABSTRACTS FROM FOREIGN PERIODICALS,
TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Engineering.*

STEEL Brushes for cleaning rough Pig Iron.—Pigs of iron, when taken from the moulds, are always covered with a considerable quantity of sand, which has combined with oxide of iron at the fusion temperature, so as to form a very hard crust, which it has been hitherto necessary to remove by the file or graver, in order to make the metal visible. M. Berthold, of Dresden, professes to have discovered a readier and more efficacious method of doing this. He makes use of steel brushes, formed with spring plates, such as were used for making crinolines. They are arranged as plane-irons, collected and placed side by side. Thus mounted, they continue sharp for a long time, and are handier for use than the graver or the file. *Technologiste, Feb.* 5, 1876.

Emery Grindstones.—The following is the way in which emery grindstones are made at the workshops of Herr Massei, a machine-maker near Munich. Gum-lac is dissolved in alcohol, and in this solution, which is poured into a heated iron mould, is sifted as much emery or quartz powder as it can take, that is to say, as long as the mass continues fluid in the mould. The paste thus obtained is then strongly compressed by the hydraulic press. As a general rule, one part of gum-lac is capable of absorbing three parts of emery. But though this ratio need not be strictly maintained, it ought to be considered that the gum-lac serves only to bind the material, and that consequently an excess of this substance is more hurtful than useful. The grain of the emery ought to be carefully considered. When it is large, less gum-lac should be used than for fine-grained emery. *Technologiste, Feb.* 5, 1876.

A New Mining Powder.—Detailed accounts have been given as to the employment of a new mining powder, called *herakline*, which has been recently tried in coal mines near the Loire, in France. This compound contains, according to the patent, picric acid, nitrate of potass, and sawdust as bases. After desiccation or drying, nitrate of soda and sulphur are mixed in a state of moisture with nitrate of potass. The substance thus obtained is used either in the form of dust or sticks. This latter form appears to give the best results, by diminishing the rapidity of inflammation. The use of the nitrates ought to render the compound easily deliquescent, though the deliquescence has not been established by the experiments.

Herakline is beginning to spread in Austria, where it competes with ordinary powder. It is supplied at one franc per kilogramme (2·2 lbs.) The chief advantages of herakline in mines would be the comparative slowness of the deflagration which opens the fissures, and the harmlessness of the vapours produced. *Revue Industrielle, Feb.* 9, 1876.

The Drying up of the Zuyder Zee.—This great enterprise, which, if successful, will add an immense extent of land to Holland for cultivation, has begun favourably. The soundings, for which a credit of eight million florins (£660,000) was voted last July, give most satisfactory results so far. Accounts differ as to the duration of the work. Some speak of twelve years, others sixteen, at least. In any case, the drawing off of the water will hardly take more than two years and eight months, according to a calculation that has been made. The total area from which the water is to be drawn is about 481,650 acres, of which 46,930 will be required for dikes, canals, roads, railroads, &c. There will remain, therefore, 434,720 acres of soil, which, there is every reason to suppose, will be good for cultivation. This land, to be called the new province of Zuyder Zee, will increase Holland by about an eighteenth part. The kingdom of Holland now consists of eleven provinces. The province of Zuyder Zee will be the tenth in magnitude out of the twelve. *Les Mondes, Feb.* 17, 1876.

Use of Cork for Covering Steam Boilers.—In our last volume (p. 316) we described the process for making slag wool, a substance recently introduced to notice in Germany as serviceable for constituting isolating coverings to prevent the loss of heat from boilers, reservoirs, steam cylinders, conduit pipes, &c. M. J. ROUSSEAU has since made a communication to the Industrial Society of Amiens with regard to the employment of cork for these purposes. He mentions several instances of this new use of cork, and specifies the favourable results obtained, especially by making use of cork coverings as a protection for boilers. They are at present covered on board ship with thick felt, which has the disadvantage of rotting very soon in consequence of the moisture. The use of cork will avoid this, and, moreover, cork is more isolating than felt, even when very dry.

But it appears that cork, in addition to its isolating properties, is very suitable as material for stuffing-boxes, and may with advantage be substituted for cotton, hemp, and even india-rubber. Various communications lately sent to the Mineralogical Society of Montluçon confirm this fact. For this purpose use is made of cork cut into small thin circular pieces, which should be well pressed together. They thus become very tight, and produce very slight friction.

The quantities of cotton, hemp, or tow constantly used to fill stuffing-boxes are considerable, especially in the case of piston-rods with large diameter. The use of cork in this last case would certainly effect a considerable saving of expense, without taking into account the time employed in making plaits, and their frequent renewal. It is desirable that further experiments should be made as to the value of a novelty which at present seems likely to be very serviceable in every point of view. *Technologiste, Feb.* 19, 1876.

The Manufacture of Tubes of Large Size.—The National Iron Tube Company, whose works are situated at M'Keesport, United States, have recently made welded wrought-iron tubes so large as 15 in. in diameter. For the boilers of Western River steamboats, the substitution of welded for riveted flues will be a great gain in strength and consequent safety, while the reduction of weight from avoidance of laps and rivets enables this improvement to be effected without addition to the total cost. The eventual substitution of wrought for cast iron pipes, and of welded tubes for riveted ones, seems to be merely a question of a supply at moderate prices, to result from the improvement of machinery and furnaces.

American Railways.—The first railroad in the United States was one of granite, which united the stone-bridge of the town Quincy in Massachusetts with the river Neponset, and was rather more than 3¼ miles long. It was devoted to a patriotic purpose, as it served chiefly for the conveyance of granite for the Bunker's Hill Monument. The concession was granted March 4, 1826, and the opening took place in April, 1827. Three years later several lines were partly completed, and the prevalence of steam commenced. Among the first-opened lines were the Baltimore and Ohio, the South Carolina, and the Mohawk Hudson, portions of which were traversed by steam in the second half of the year 1830. The total length of lines then in use was about 40 miles. In consequence of the success of these lines, railroads made rapid advances. Ten years later about 2,794 miles were open, and in 1850 the length was 7,552 miles, of which only a small part was west of the Alleghany Mountains.

In the next ten years the great lines west of the Hudson—the Delaware-Chesapeke lines—were made, and railways extended over a great part of the country east of the Mississippi, so that in 1860 the total length amounted to 28,717 miles. The States of Missouri and Iowa (chiefly with state aid), Kentucky and Tennessee (also with state aid), and the country in the south on the Gulf of Mexico were abundantly supplied with railroads, and the Mississippi was not only reached but crossed.

The civil war from 1860 to 1865 stopped the extension of railways, but even during this period the national government found time to prepare for making those great lines which unite the east with the coast of the Pacific Ocean. In the ten years from 1860 to 1870 there was an increase of about 20,000 miles of railway, so that by the end of 1870 the total of 48,810 miles was reached.

After that time from 5,000 to 6,000 miles were added every year, till, in September 1873, the financial crisis caused a general stoppage of the works, with the exception of some lines of special importance sustained by foreign capital. Meanwhile the great lines have been improved and completed, and fresh lines added for the increased traffic. The present year which is the centenary of the Declaration of Independence, presents a total length of 91,535 miles, at a cost of 3,941,333,197 dollars (about £800,000,000 sterling), giving an average of about £8,650 per mile.

A Steam-Carriage at New York.—The steam-carriage tried at Brooklyn, comes from Baldwin's workshop, and seems free from the objections to which such vehicles are generally liable. It is said to burn its own smoke, to have no steam-blast, to move without noise and to have a steam-brake which stops it almost instantly. It is not much larger than ordinary vehicles. The boiler is under the platform in front, and nearly all the mechanism is below the body of the carriage. Its

mechanism can be applied to ordinary vehicles without much alteration. In the trials at Brooklyn the journey was performed in about half the usual time.

Krupp's 126 Ton Gun.—At Krupp's workshop preparations are going on for making a gun weighing 126 tons, the plans of which are nearly completed. The following are the dimensions of this gun compared with the English 81-ton gun:

	Krupp's.	English.
Bore	17½ in.	11½ in.
Length of the rifled part	20 ft. 10 in.	23 ft. 9 in.
Total length	unknown	26 ft. 6 in.
Weight of gun	126 tons	81 tons
Weight of projectile	2,305 lbs.	1,656 lbs.

Krupp's gun is to go through a plate 2 ft. thick at a distance of 1,257 yards. *Moniteur Industriel Belge, Feb.* 20, 1876.

A Central Asiatic Railway.—M. COTARD, an engineer, lately made a communication to the French Geographical Society with regard to his scheme for a railway to traverse the whole of Asia, and connect India with Europe. In spite of the many physical, financial, and political obstacles which it has to meet, it is regarded with favour by some, partly perhaps because it enjoys the patronage of M. de Lesseps, who has so signally triumphed over difficulties that were declared to be insurmountable.

At the request of Prince Orloff, who also is favourable to the project, the Emperor of Russia granted an audience to M. de Lesseps, and authorized him to commence preliminary proceedings. Moreover, General Ignatieff, who is well acquainted with the country to be traversed, gave him useful information. A fund was raised for the first exploring expedition, an account of which was published by M. Stuart in the "Explorateur." Meanwhile, M. Cotard in Russia was in constant communication with the agents of the Russian government.

Rejecting all previous projects, M. Cotard proposes the construction of a line of railway from Orénburg, through Tashkand and Balkh to Peshawur, a distance of 3,800 kilometres (2,360 miles). The total cost is estimated at £40,000,000 sterling, or about £10,600 a mile. As the fare would be below the expense of travelling by the present route, and distance and time would be saved, travellers would naturally prefer the railway. Eleven days would suffice for going from Paris to Calcutta, and the fare, including board, would be £60. M. Cotard reckons upon 100,000 passengers a year, and a goods traffic of 100,000 tons a year. *Abridged from the Moniteur Industrielle Belge, March* 10, 1876.

A Method of Preventing Explosions of Fire-damp.—M. BUISSON, in a communication to the French Academy of Sciences, says:—

Having had long experience of the circumstances in which coal miners are placed, I have considered how it might be possible to ameliorate their position, which is always unhealthy, and occasionally so frightfully fatal.

Instead of the present ventilation apparatus, which act as bellows, and, by injecting air from without through the opening of the galleries, have the effect of crowding the deleterious gases at the bottom of the galleries, I propose to employ pipes conveying a pure and compressed air directly to the bottom of the mines. This air, escaping through the orifice of taps placed at the end of branching pipes proportioned in number to that of the galleries, would drive the vitiated air of the mine into the ventilating shaft by an action from behind or from within outwards. It would also have the effect of cooling the internal atmosphere on dilating when set at liberty, and would thus render it more healthy. *Comptes Rendus, Feb.* 28, 1876.

Sixty Foot Rails.—The Edgar Thompson Steel Works have filled an order for 60 foot rails. Several advantages are claimed for rails of this length. They cost no more per pound than 30 foot rails; and as two crop ends are saved, the cost of production is considerably lessened—no way of using crop ends economically having yet been devised. The cost of laying is lessened; fewer fish plates, etc., are required; and as the hammering caused by the rolling stock in passing from rail to rail is lessened by one half, the wear and tear of rails and rolling stock must be greatly diminished. On bridges, also, the strain will be greatly reduced. The practical results of the use of these rails will be awaited with considerable interest. *Chicago Railroad Review.*

§ 2. *Building, Decoration, &c.*

Process for giving Paper and Wood Surfaces a Crystalline Coating.—According to Prof. Böttger, the simplest method of giving paper and wood surfaces a crystalline coating is as follows:—Mix a very concentrated cold solution of salt with dextrine, and lay the thinnest possible coating of the fluid on the surface to be covered, by means of a broad soft brush. After drying, the surface has a beautiful bright mother-of-pearl coating, which, in consequence of the dextrine, adheres firmly to paper and wood. The coating may be made adhesive to glass by doing it over with an alcoholic shellac solution.

Prof. Böttger mentions the following salts as adapted to produce the most beautiful crystalline coating:—sulphate of magnesia, acetate of soda, and sulphate of tin. Paper must first be sized, otherwise it will absorb the fluid and prevent the formation of crystal on its surface. Visiting cards with a mother-of-pearl coating have for some time been in use. Coloured glass is well adapted for such a coating, which has a good effect when the light shines through. *Bayerisches Industrie-und-Gewerbe Blatt, Dec.* 1875.

Wood Wall-paper.—The use of wood for wall-paper is not a novelty, but a great improvement in its preparation has been lately made by Mr. C. W. SPURR, of Boston in America. The wood is cut to the thickness of paper, and by a peculiar process stuck on to the paper, which serves as a protection against the influence of the walls on the graining and colour of the wood. The delicacy of the machinery employed in cutting so thin a veneer may be gathered from the fact that 200 leaves are cut out of an inch of white maple-wood, and 125 out of wood with very open grain, such as oak and nut-wood.

New Mode of Hardening Sandstone.—In Saxony, sandstone is soaked in a solution of alkaline silicates and of alumina. The liquid penetrates some inches into the stone, and renders the surface so hard that it resembles marble and will bear polishing. On being heated to a high degree, the surface vitrifies, and it may be coloured at pleasure.

MACHINE MERCY.

WHILE crossing one of the ferries between this city and Brooklyn the other day, we formed one of a knot of persons who curiously watched an individual who had clambered up on the working beam of another steamboat that was passing us, and who, clinging to the beam, was swayed up and down as he coolly scrubbed at some portion of the bright work. The general sentiment of the people about us seemed to be one akin to admiration at the man's daring; but in that view we profoundly differed from our neighbours, and thought to ourselves that the workman was, to say the least, a fool. Why could he not wait five minutes until his boat came to rest in the slip, and then clean and polish to his heart's content while the beam was stationary? In fact there was no reason that we could perceive, and hence we were driven to the above uncomplimentary opinion, as we always are whenever we witness a presumably rational human being peril life or limb uselessly.

"Familiarity breeds contempt" is a trite old proverb, and one which appears to be especially true in regard to people accustomed to dealing with machinery. It is not so in many other cases; soldiers who handle fire arms and explosives all their lives are proverbially the most careful persons with their deadly weapons. They seldom blow off their fingers or the tops of their own skulls through pure negligence, as many an unfortunate sportsman has done, for the reason, perhaps, that long experience with gunpowder impresses them with the merciless nature of that material when it is ignited. But machine attendants somehow manage to get a different idea, and almost, it appears, arrive at a notion that a machine is a sort of sentient being which knows them, and won't smash or bite off their limbs as it will those of other people. What scores of workmen we have seen with stumps of fingers! Machine and circular saws especially are peculiarly partial to such diet. We read of a case recently of a workman who was descanting on the advantages of his saw, and who merely wanted to point out how truly it ran. He pushed his finger forward a little too far, and whiz! off it went. He felt a peculiar sensation, not a hurt (for it is well known that there is no pain attending the lopping off of a member by a very rapidly revolving blade), and, half instinctively, he poked out another finger, and that likewise departed. Then he discovered that something was wrong, and subsequently that he was *minus* two fingers. Fingers cut off are trivial accidents to some that occur through carelessness. Not very long ago, a woman in a New England mill went to work with her hair down. She moved carelessly around among the buzzing wheels and

shafts, and the first thing she knew her tresses were caught, and no Pawnee on the plains could have scalped her more neatly. Her misfortune benefited science, however, for it gave the doctors a splendid opportunity to try the efficacy of transplanting skin. Medical skill healed the wound, we believe, but her flowing locks were gone. A workman was strangled in a somewhat similar way, his loose neckcloth catching and twisting itself about a shaft, which could not be stopped in time; another, we remember, met a more horrible fate by becoming entangled with a shaft which swung him around and around, dashing him against the beams and floor at every turn, until, before the motion could be arrested, he was literally torn to pieces. We have seen men on steam vessels crawl down among the machinery with a light in one hand and a tool in the other, and try to work, dodging some moving part at its every revolution, the rolling of the ship making their position still more perilous. A case happened a very short time ago, in which a machinist entered the narrow enclosure in which the paddle shaft crank of a steamer worked. He knew perfectly well that steam was up, and that the vessel would shortly get under weigh; but, for some unaccountable reason, he chose at the last minute to get under the crank, perhaps to put the last touch on some repairing job. It was his last touch, for the engineer, whom he did not notify of his intention, happened to work the starting bar to give the engine a turn or two. The crank came over and smashed the unfortunate being out of all human semblance.

We might go on and multiply instances of this kind indefinitely; doubtless there are few of our readers who cannot do likewise. But despite the knowledge of the prevalence of these casualties people continue to be careless. The engineer doesn't realize that the engine which he has rubbed till he can see his face in any part of it, or whose motion he has controlled for the last ten years, will crush him if he once gets in its clutch. Hasn't he a pet name for it, and doesn't he pat the cylinder affectionately, and view it all over with a kind of fatherly interest? Certainly he reasons somehow that the insensate iron and steel will spare its master. Then there is the machinist. Did he not put up those countershafts, and fit that belting? What if he does get up on a ladder, and try to slip a belt already on the driven pulley over a big driver with the latter in motion? He laughs when the risk of his getting caught between belt and pulley is pointed out, guesses he knows this gear, and "he's done it a thousand times," and the thousand and first time may result in a horrible death. Locomotive engineers are also frightfully reckless. With an engine going forty miles an hour, it is much more prudent to slow down or even stop in order to oil a squeaky bearing than to climb out on the side and hang over so as to reach the place with the oil-can. Better lose a minute or two of time than risk life. The men who run our locomotives have plenty of chances to display heroism and daring at the right time; and it is for the very reason that they are so rarely found wanting in those qualities that we hate to see them uselessly peril their lives.

In a word, workmen should learn that there is no such thing as familiarity with machinery. Study your machines, we say, know every bolt, every nut, every piece of metal in them, know how to repair, to build, to invent improvements, know how to exact their utmost capabilities; but for your own safety, and for the sake of those dependent on your labour, do not relax one instant's care, nor persuade yourself that you can rely upon your dexterity or upon any half-supposed merciful attribute in moving masses of metal. *Scientific American.*

DUBIED'S STEAM PISTON.

THE general arrangement of Dubied's steam piston presents nothing particularly new. It is composed of two outer rings or segments, placed one on the other, cast, elastic, in one piece, and slit at one point in their circumference. Inside is a third elastic segment, also in one piece, and slit like the other two. Its height is equal to that of the other two together. These segments are adjusted carefully on each other, as well as between the body of the piston and its lid.

In the body of the piston three screws are wormed, which rest with their extremities on the inner segment. They are for perfectly centring the body of the piston in the steam cylinder. On each of these screws is fastened, by means of a pin, a disc fluted on part of its length. A tooth or projection, fixed on a spring below, catches in the teeth of the fluting, and thus prevents the disc and the screw from getting loose.

The improvement effected results from the mode of construction, which will be described hereafter. Its object is to give the segments the elasticity required in order that the pressure of the segments from within outwards may be uniform over their whole extent, and proportional to the surface of contact, whatever be the extent and position of the portion of this surface in view.

If it is desired that an elastic segment in one piece slit in a single point should exert a uniform pressure, in a perfectly round cylinder, at all points of its outer surface, it will be sufficient:—

1. To subject it (when it is perfectly free) at several equidistant points of its outer circumference to a series of equal pressures from within outwards, in the direction of the radii, passing through the points, the sum of these pressures being equal to the total pressure which the segment is to exert on the cylinder.

2. To bring about a series of turnings and drillings, when it has freely taken a fixed position under the action of these pressures, till the thickness and internal and external diameters desired are obtained.

After each operation the segment will be left perfectly free, then it will be again subjected to the action of equal pressures. When it has assumed the form resulting from these pressures it will be firmly fixed on the face-plate of the turning lathe on which it is mounted, so that it may retain this form when the action of the pressures is suspended. After this another turning will be performed, and care will be taken, in the latter operations, to take away only a small quantity of material with the cutting-tool.

Every one will admit, without more detailed explanation, that this mode of construction will produce a segment provided with the properties stated above. The apparatus, on which the segment is fixed to make it undergo the above-mentioned operations, is a sort of mandrel or plate of special construction, mounted on the lathe-shaft, and on it are adjusted twelve moveable wrought-iron sliding puppets, capable of moving from or towards the axis of revolution by the action of twelve screws. The two branches of each puppet are pierced with holes for a spike to go through, round which is coiled a spiral metallic spring. This spring urges the spike towards the centre of the lathe, its pressure being transmitted to two points of the segment by a piece, the two ends of which rest on the outer surface of the segment, which is thus acted upon by 24 equal pressures at 24 points of its circumference. For segments of a large diameter it will be necessary to increase the number of pressures.

The twelve spikes are wormed on the outer side, and have each nuts, the position of which corresponds to the pressure the spring is to exert on the segment. To determine the position of these nuts, and before mounting the segment on the plate, all the spikes are brought one after the other into the vertical position, the wormed part being below. The piece is taken away and the spike is laden with a weight equal to the pressure to be exerted on the segment. When the spring has been compressed under the action of this weight, the nuts are turned on the spike, and fastened one above the other in such a way as to bring the nut to a short distance from the lower branch of the puppet. When the nuts of all the branches have been thus arranged, the segment is mounted on the turning-lathe, the pieces are put in their places, and brought into contact with the segments by making the screws revolve till the nuts begin to move away from the outer branches of the puppets. After this operation, which requires some care, but is nevertheless performed rapidly, the segment, being acted on by 24 equal pressures, is firmly fixed to the plate.

If it is desired to turn the segment on the outside, it is fastened by means of bolts, and a complete disc, on a cast-iron piece. If on the contrary it is to be drilled, use is made of a fastening ring, and a supporting ring. In the first case only the puppets of the segment are removed after the nuts of the bolts have been fastened.

The inner segment is worked by the same process.

In the piston the pressure exerted against the cylinder by the outer segments is the resultant of the pressures due to their elasticity and that of the inner segment.

The piston represented in our illustration has been at work for a year in the cylinder of the inventor's steam-engine, who had to alter the original piston of the engine, as the contact of the segments with the cylinder was not satisfactory. It was after ascertaining the inconveniences involved in giving the rings the required elasticity, by hammering or by compression of the ring without any rational method on the turning-lathe before the turning, that the inventor was led to adopt the process described above, which allows the elasticity corresponding to the uniformity of pressure to be obtained directly, and without any imperfect trials.

He became convinced, as will be easily understood, that his

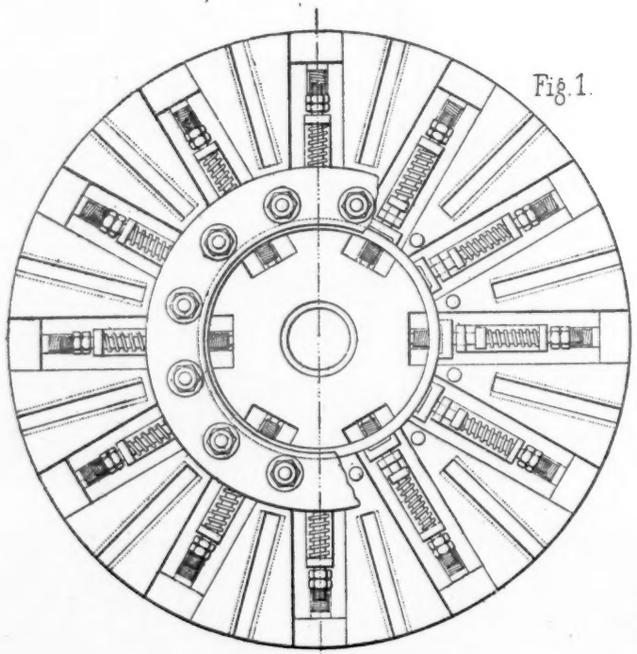

Fig. 1.

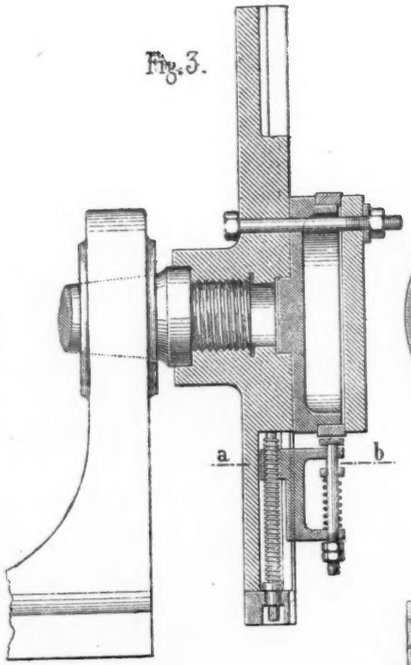

Fig. 3.

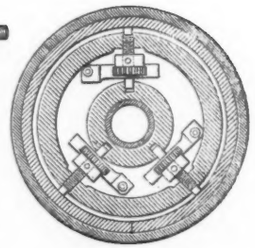

Fig. 5.

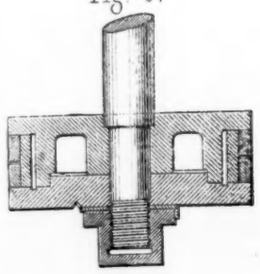

Fig 6.

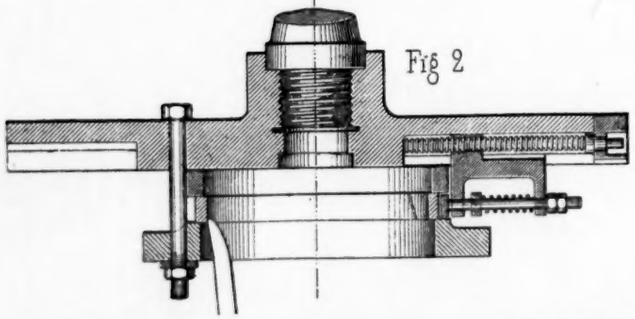

Fig 2

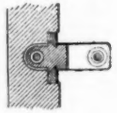

Fig 4. Coupe **ab**.

DUBIED'S STEAM PISTON.

segments having an elastic pressure uniformly diffused, a perfect tightness is obtained with a comparatively feeble tension.

In the piston the two outer rings, compressed during the turning at 24 points by 12 springs with a tension of 7 kilogrammes (15·4 lbs.), each exert on the cylinder by their elasticity a total pressure of $7 \times 12 = 84$ kilogrammes (184·8 lbs.).

The inner segment, compressed during the turning by 12 springs with a tension of 15 kilogrammes (33 lbs.), adds to these pressures $12 \times 15 = 180$ kilogrammes (396 lbs.). Hence the total of the pressures exerted on the cylinder is $84 + 84 + 180 = 348$ kilogrammes (765·6 lbs.).

The diameter of the steam cylinder being 196 millimetres (7·6 in.), the sum of the heights of the rings, 42 millimetres (1·6 in.), the outer surface of the segments is $\pi \times 19{\cdot}6 \times 4{\cdot}2 = 259$ square centimetres (39·39 sq. in.).

The pressure exerted on the cylinder per square centimetre is consequently $\frac{348}{259} = 1{\cdot}34$ kilogrammes (2·9 lbs.).

In these conditions the piston, being perfectly steam-tight, works in the cylinder easily, under the pressure of the boiler, which amounts to five atmospheres above atmospheric pressure.

At the Vienna Exhibition a piston was exhibited exactly like the one described above in make and size. Near the piston was the mandrel or plate employed for making the segments. The processes of manufacture are not patented, and may consequently be employed by machine-makers without payment of royalty to the inventor. *Revue Industrielle, Jan.* 19, 1876.

Practical Literature.

DESCRIPTIVE GEOMETRY, WITH A THEORY OF SHADOWS AND OF PERSPECTIVE.[1]

THIS volume is further described on the title page as the "Third Course of the Elements of Mathematical Drawing," and as being intended as an introduction to the application of descriptive geometry to various branches of the arts. It is based on the work of Mons. G. Monge, and while, of course, less limited in extent than that work, it goes beyond it in that some parts are compiled from Mons. Monge's unpublished lectures, which have been translated by the editor of a recent edition of his book.

One of the well-known Weale's Series, it has already obtained a position in our educational literature, and we are glad to see that a need for a new edition has arisen. It is well illustrated, and the account of the principles and practice of isometric projection, as well as the chapters on shadows and perspective, appear to be carefully written, and they expound somewhat difficult subjects with remarkable clearness.

SHOOTING: ITS APPLIANCES, PRACTICE, AND PURPOSE.[2]

A WONDERFUL story is told—from America, of course—of a feat with the gun which eclipses even the marvellous adventures of the single bullet that shot an incredible number of animals with the aid of two guns, one being placed on the offside of the beast to receive the shot from the other after it had duly perforated the body of the victim. This story goes that a large number of wild fowl were driven by wind to the corner of a lake; an adventurous sportsman seeing them discharged his double-barrelled shot-gun into their midst. For a moment no effect was seen, but presently the birds rose into the air in a body, and after ascending a hundred yards or more down fell a shower of dead and wounded. They had been so tightly wedged in by the live ones that they had been carried up *en masse*. Such luck as this seldom attends the ordinary sportsman, but under Mr. Dougall's tuition we should not be surprised—if the learner only fulfils the author's prophecy, quoted from Marlowe, on the title-page,

> "First I'll instruct thee in the rudiments,
> And then thou wilt be perfecter than I"—

if even still more wonderful doings are heard of.

But in all seriousness, and although the book seems to us to be more fitted for the matured sportsman than for the beginner, we have seldom met with a more pleasant or more efficient instructor than our author, and we certainly have never read a more practical and withal agreeable treatise on this our great national mode of relaxation. An ardent sportsman, thoroughly versed in all the practical details of the production of the implements of his craft, and consequently alive to the merits and defects of every article in the market, and no less acquainted with the haunts and habits of all the game which our islands produce, can have no better companion, the tyro no surer guide; and even the gentlemen who, by choice or necessity, must stay at home at ease, cannot but be infected by the enthusiasm of the book, or interested in the admirable descriptions of the homes and haunts of the furry and feathered tribes which the sportsman loves to seek and to slay.

To give anything like a description of its contents would need a much larger space than we have at our disposal in this section of the Magazine. Every part of the implements of sport is carefully described, its uses are pointed out, and the reader is assiduously warned against the possible ways in which it may be abused. To the breechloader, of course, especial prominence is given, and all the most recent modifications and appliances are described and discussed; the important subject of ammunition is fully treated of, and the question of the sportsman's dress is not overlooked; while the instructions for the field, the choice, care, and training of dogs, and the descriptions of various kinds of game, are exhaustive, and written in pleasant and entertaining style. Altogether the work is one to which we have pleasure in calling our readers' attention, as one from which the manufacturer may learn something that may be to his practical advantage, containing, as it does, the opinions of a most accomplished sportsman on his productions, and as a book which must possess an interest and an attraction for every English gentleman.

IMPROVEMENT IN ELECTRIC ILLUMINATION.

IT is well known that the electric light is due simply to the electric current heating the medium it passes through; and the more resistance is offered to the current, the greater is the heat developed. The great intensity of the ordinary electric carbon lamp is owing to the badly conducting layer of atmosphere between the carbon points, and the layer being very much heated makes the carbon burn with a white glow. By reason of the great resistance of this layer of atmosphere, which only a powerful current can overcome, the light must necessarily be a very brilliant one.

It is possible, without the aid of air or gas, to make a solid body quite hot, as, for instance, in the case of a platinum wire; the illumination thus produced is, however, weaker and more uniform, and may be intensified or diminished. But it cannot be applied practically by reason of its great expense, and because, if the heat becomes too intense, the wire is apt to fuse. For this reason the idea struck Ladiguin to replace the platinum wire with thin bars of graphite or carbon. This graphite possesses, at an equal temperature, much greater radiating properties than platinum. The heat capacity of the latter is twice that of the carbon, so that the same temperature will heat a thin bar of graphite to double the degree which would be attained by a platinum wire of the same dimensions under similar circumstances. Moreover, the electric resistance of the carbon in question is about two hundred and fifty times that of platinum, and the carbon rod may be fifteen times as thick as a platinum wire of the same length, supposing the current is to give the same amount of heat. Finally, there is no disposition for the carbon to melt, even at the highest temperature.

For these reasons the Ladiguin method of electric illumination may be regarded as a most valuable one, as, indeed, it has already proved to be. The only drawback to it seems to be that the carbon gradually combines with the oxygen of the atmosphere and burns away; but this defect the inventor has overcome by confining the carbon in an air-tight glass, from which the oxygen has been removed in the simplest manner, and replaced by nitrogen. *Polytechnisches Notizblatt.*

[1] *Descriptive Geometry, with a Theory of Shadows and of Perspective.* By J. F. Heather, M.A., late of the Royal Military Academy, Woolwich. New edition, revised and partly re-written. London: Lockwood and Co., 1875.

[2] *Shooting: its Appliances, Practice, and Purpose.* By James Dalziel Dougall, F.S.A., F.Z.A., Author of "Scottish Field Sports," &c. London: Sampson Low, Marston, Low, and Searle, 1875.